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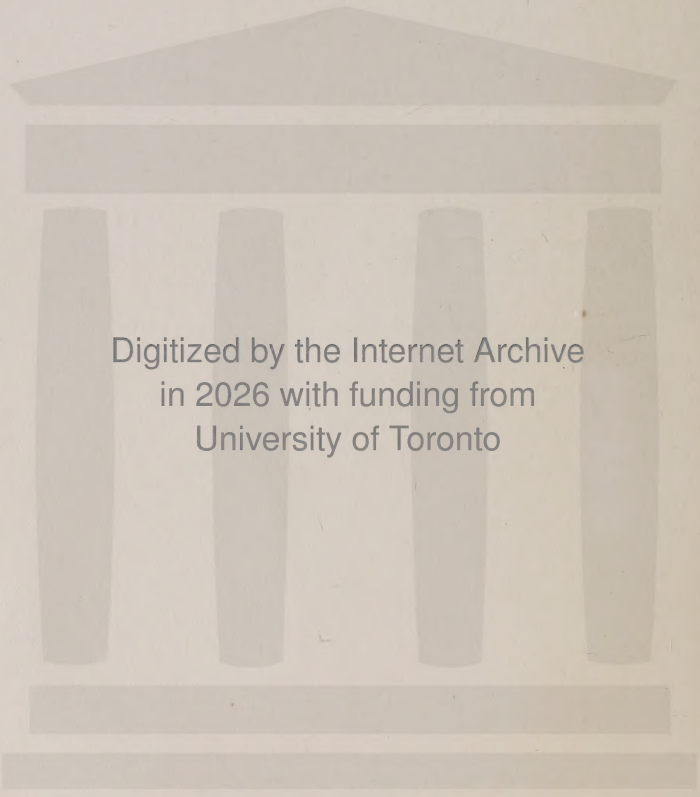
# MINERAL TABLES



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# MINERAL TABLES

## FOR THE DETERMINATION OF MINERALS BY THEIR PHYSICAL PROPERTIES.

BY

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*SECOND EDITION, REVISED*

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# PREFACE TO SECOND EDITION.

In this new edition of the Tables, no change has been made in the arrangement of the minerals primarily by their streak, color and hardness, as it has been well demonstrated, in the years since the tables were first issued, that such an arrangement gives the student the surest and quickest means of identifying minerals. Tables depending wholly upon physical properties as a means of identification have their limitations; it has, therefore, been very gratifying to the author to see how few errors the careful observer makes in using these tables.

A few additions and corrections have been made in this edition; the tables now contain about two hundred minerals, including all the common ones and others that are rarer, some of them of local prominence.

The natural method of identifying minerals is by using those characters which are prominent or which can be determined in the field or laboratory in the simplest manner. Practice in the determination of minerals by their physical properties tends to develop the habit of close and careful observation, and at the same time enables the student to acquire more knowledge of minerals in a given time than could be obtained by any other method. Experience has demonstrated that work in blowpipe analysis is less apt

to become merely mechanical if it has been preceded by such practice.

The author has been greatly assisted by valuable suggestions from many users of the tables, and takes this occasion to express his indebtedness to them.

BERKELEY, February 20, 1923.

# MINERAL TABLES.

## PHYSICAL PROPERTIES.

THE only apparatus needed for the tables is a pocket-knife, a horse-shoe magnet, a pocket-lens, a piece of unglazed porcelain or streak-plate, and a scale of hardness consisting of nine minerals. This scale can be procured of any mineral dealer or can be made up of specimens from an ordinary collection of minerals.

**Color.**—The color of a mineral is perhaps the most important property used in its identification, yet it is the most difficult to accurately describe. A mineral may have but one characteristic color, or it may occur in various colors and shades; consequently a mineral may be repeated several times in the tables. The color must always be judged by the fresh surface or fracture, and it should be homogeneous throughout the mineral. Vitreous minerals may often be discolored or stained by impurities, when they manifestly belong to the colorless or white class.

**Luster.**—The luster of a mineral refers to the kind of reflected surface. The common kinds are: *metallic; submetallic*=imperfect metallic; *vitreous*=glassy; *adamantine*=brilliant oily luster; *resinous; greasy; pearly; silky; waxy.*

**Streak.**—The streak of a mineral is the color of its fine powder. It is best obtained by rubbing the specimen upon the streak-plate until a definite color is produced.

**Hardness.**—By hardness is meant the resistance that a mineral offers to abrasion or scratching. The relative hardness of a mineral is usually determined by scratching it successively by minerals or substances of known hardness, two minerals of the same hardness mutually scratching each other. The scale of hardness in common use, called the Moh's scale, in ascending degree of hardness, is as follows: 1, Talc; 2, Gypsum; 3, Calcite; 4, Fluorite; 5, Apatite; 6, Feldspar; 7, Quartz; 8, Topaz; 9, Corundum; 10, Diamond.

The thumb-nail will scratch minerals up to $2\frac{1}{2}$, and the ordinary knife-blade up to $5\frac{1}{2}$ in the scale; with a little practice the relative hardness of a mineral under 6 can be approximately determined with a knife-blade. Above 6 the scale of hardness is necessary. The relative hardness of many of the metallic or submetallic minerals can often be judged by the ease or difficulty in obtaining a streak on the streak-plate. Fine fibrous and fine granular minerals usually appear to be much softer than the individual fiber or grain would be, if it were coarser. Also the surface of some minerals is often much softer than the fresh interior, owing to alteration.

**Specific Gravity.**—The gravity of a mineral is its weight compared with the weight of an equal volume of water. It is determined by first weighing the mineral in air and then weighing it suspended in water. If $w$ = weight in air, and $w'$ = weight in water, then $G = \frac{w}{w - w'}$. The gravity of minerals can be determined with a chemical balance or

with the convenient Jolly spring-balance. Whether the mineral is light, medium, heavy, or very heavy can often be judged simply by hefting it.

**Crystallization.**—A few mineral substances on assuming a solid condition do not crystallize and are said to be amorphous, but most mineral substances when solidifying have the property of crystallizing into certain definite crystal forms, and any such crystalline substance must belong to one of six different crystal systems. These systems are: 1, *Isometric;* 2, *Tetragonal;* 3, *Hexagonal;* 4, *Orthorhombic;* 5, *Monoclinic;* 6, *Triclinic.*

Assuming that each system has axes which are intersected by the crystal planes, then:

1. *Isometric* has three equal axes all at right angles. The common forms in this system are: *Cube,* having six square faces; *Octahedron,* having eight equilateral triangular faces; *Rhombic dodecahedron,* having twelve rhombic faces; *Icosatetrahedron* or *Trapezohedron,* having twenty-four trapezohedral faces; *Tetrahedron,* having four equilateral triangular faces; *Pentagonal dodecahedron* or *Pyritohedron,* having twelve pentagonal faces.
2. *Tetragonal* has two horizontal axes equal, and one vertical longer or shorter than these, all at right angles. The common forms are: *Prisms,* faces intersecting one or both horizontal axes, and parallel to the vertical; *Pyramids,* faces intersecting the vertical and one or both horizontal axes; *Basal pinacoids,* faces intersecting the vertical and parallel to the horizontal axes.

3. *Hexagonal* has three horizontal axes equal and making angles of 60° with each other, and one vertical, longer or shorter than these, and at right angles to them. The common forms are: *Prisms,* faces intersecting two or three of the horizontal axes and parallel to the vertical; *Pyramids,* faces intersecting the vertical and two or three of the horizontal; *Basal pinacoids,* faces intersecting the vertical and parallel to the horizontal; *Rhombohedrons,* solids of six oblique rhombic faces; *Scalenohedrons,* solids of twelve scalene-triangular faces.

4. *Orthorhombic* has three unequal axes all at right angles: a short forward-and-back horizontal axis, the brachyaxis; a long right-and-left horizontal axis, the macroaxis; and a vertical axis. The common forms are: *Prisms,* faces intersecting the horizontal axes and parallel to the vertical; *Pyramids,* faces intersecting the three axes; *Macropinacoids,* faces intersecting the brachyaxis and parallel to the other two; *Brachypinacoids,* faces intersecting the macroaxis and parallel to the other two; *Macrodomes,* faces intersecting the brachyaxis and the vertical and parallel to the macroaxis; *Brachydomes,* faces intersecting the macroaxis and the vertical and parallel to the brachyaxis; *Basal pinacoids,* faces intersecting the vertical and parallel to the horizontal axes.

5. *Monoclinic* has three unequal axes: a forward-and-back inclined axis, the clinoaxis; a right-and-left horizontal axis, the orthoaxis; and a vertical axis. The common forms are: *Prisms,* faces intersecting the two lateral axes and parallel to the vertical; *Pyramids,* faces intersecting all three axes; *Ortho-*

*pinacoids,* faces intersecting the clinoaxis and parallel to the other two; *Clinopinacoids,* faces intersecting the orthoaxis and parallel to the other two; *Orthodomes,* faces intersecting the clinoaxis and the vertical and parallel to the orthoaxis; *Clinodomes,* faces intersecting the orthoaxis and the vertical and parallel to the clinoaxis; *Basal pinacoids,* faces intersecting the vertical and parallel to the other two.

6. *Triclinic* has three unequal axes, all oblique to each other. The common forms are the same as in the orthorhombic system, namely, *Prisms; Pyramids; Macropinacoids; Brachypinacoids; Macrodomes; Brachydomes; Basal pinacoids.*

**Twinning.**—Some crystals instead of being simple individuals are made up of two crystals, not in parallel position, but united along a plane common to both, and such crystals are said to be twinned. Twinning is usually indicated by reentrant angles between the faces.

**Cleavage.**—The property which a mineral has of splitting or breaking along certain definite directions is called cleavage. The cleavage is always parallel to a possible crystal plane, and the kind of cleavage is designated by the name of the plane to which it corresponds in direction. The common kinds of cleavage for each system are·

*Isometric,* cubic, octahedral, and dodecahedral.

*Tetragonal,* basal and prismatic.

*Hexagonal,* basal, prismatic, and rhombohedral.

*Orthorhombic,* basal; prismatic; macro- or brachypinacoidal.

*Monoclinic,* basal; prismatic; ortho- or clinopinacoidal.

*Triclinic,* basal and macro- or brachypinacoidal.

The direction of cleavage can usually be determined only on the

actual crystal and not on the average massive mineral specimen. Bright, smooth cleavage faces are, however, usually present on specimens of minerals which possess good cleavage, and often they are very prominent.

**Fracture.**—When the direction of breakage is not definite, but occurs in any way irrespective of crystal planes, the mineral fractures. The fracture may be *even; uneven; rough; conchoidal* = rounded, shell-like; *splintery;* these terms referring to the kind of surface.

**Tenacity.**—The terms used to denote the tenacity are:

*Malleable,* when the mineral can be flattened by hammering.

*Sectile,* when it can be cut with a knife but will break in pieces by hammering.

*Brittle,* when it will break in pieces by hammering.

*Tough,* when it is difficult to break by hammering.

**Structure.**—Most minerals do not occur as simple individual crystals in nature, but rather as aggregates of imperfectly formed crystals, or simply as crystalline masses. Some of the terms used to describe the structure of specimens are:

*Massive,* when the specimen has an irregular, indefinite shape. It may be fine or coarse granular.

*Crypto-crystalline,* extremely fine crystalline; *impalpable* = extremely dense, compact.

*Fibrous,* composed of fibers. The fibers may be parallel, radiate, or divergent in any direction.

*Columnar,* stout fibrous, forming columns.

*Capillary,* hair-like fibers.

*Acicular,* needle-like.

*Reticulated,* when the fibers cross each other, forming a net-like structure.

*Mammillary,* large rounded surfaces.

*Reniform,* kidney-shaped masses.

*Botryoidal,* grape-like structure or small rounded surfaces.

*Geodal,* cavities lined with crystals.

*Drusy,* rough surfaces due to innumerable small imperfect crystals.

*Micaceous,* thin sheets or scales, like mica.

*Lamellar,* thin plates.

*Foliated,* thin leaves.

Other terms are used to describe the structures of mineral specimens, but their meaning in general is self-evident.

# ANALYTICAL KEY.


PAGE

1. STREAK DARK GRAY OR BLACK:
   - Color: Dark Gray or Black ..... 10–12
   - Metallic White to Light Metallic Gray ..... 12–14
   - Brass; Bronze; Copper-red or Brown ..... 14–16

2. STREAK METALLIC WHITE TO LEAD- OR STEEL-GRAY:
   - Color: Metallic White or Light Metallic Gray ..... 16

3. STREAK RED OR RED-BROWN:
   - Color: Red or Brown ..... 18
   - Dark Gray or Black ..... 20–22

4. STREAK YELLOW OR YELLOW-BROWN:
   - Color: Red ..... 22
   - Yellow ..... 22–24
   - Brown or Black ..... 24–26
   - Green ..... 26

5. STREAK BLUE OR GREEN:
   - Color: Blue, Green, or Black ..... 26–28

6. STREAK UNCOLORED, WHITE OR LIGHT GRAY:
   - Color: Yellow or Brown ..... 28–38
   - Pink, Red, or Red-violet ..... 38–44
   - Blue or Blue-violet ..... 44–46
   - Green ..... 46–54
   - Black ..... 54–56
   - White, Gray, or Colorless ..... 56–68

COLOR DARK GRAY OR BLACK.

| Name. | Composition. | Color. | Streak. | Luster. | H. |
|---|---|---|---|---|---|
| **GRAPHITE** | C | Dark steel-gray<br>Iron-black | Black<br>Dark silver-gray | Metallic<br>Dull | **1**<br>**2** |
| MOLYBDENITE | $MoS_2$ | Bluish lead-gray | Lead-gray<br>Sometime greenish | Metallic | **1**<br>**1.5** |
| MELACONITE | CuO | Black | Black | Dull<br>Earthy | **1**<br>**2** |
| **PYROLUSITE** | $MnO_2$ | Black<br>Blackish Gray | Dull black | Metallic<br>Dull | **1**<br>**2** |
| **STIBNITE** | $Sb_2S_3$ | Dark lead-gray | Dark lead-gray<br>Black | Metallic | **2** |
| ARGENTITE | $Ag_2S$ | Dark lead-gray<br>Black | Dark lead-gray | Metallic | **2**<br>**2.5** |
| STEPHANITE | $Ag_5SbS_4$ | Iron-black | Iron-black | Metallic | **2**<br>**2.5** |
| POLYBASITE | $Ag_9SbS_6$ | Black | Black | Metallic | **2**<br>**2.5** |
| **GALENITE** | PbS | Dark lead-gray | Grayish black<br>Dark lead-gray | Metallic | **2.5**<br>**3** |
| **CHALCOCITE** | $Cu_2S$ | Dark lead- or steel-gray<br>Black | Dark gray<br>Black | Metallic | **2.5**<br>**3** |
| ENARGITE | $Cu_3AsS_4$ | Grayish black | Grayish black | Metallic | **3** |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Hex. | C, basal, perfect in crystallized masses; sectile; flexible | 2.2 | Foliated; scaly; massive; granular; earthy | Feels greasy; plates highly flexible; inelastic; occurs with calcite; darker than molybdenite |
| Hex. | C, basal, very prominent; sectile; flexible | 4.7 | Foliated; massive; scaly; flaky | Soft and greasy like graphite but lighter colored; usually as flakes in white massive quartz or feldspar |
| Mono. | C, none<br>F, earthy | 5.8 | Crusts<br>Sooty coatings | Occurs as black coatings on chalcopyrite, chrysocolla and other copper minerals |
| Orth. | C, none<br>Brittle | 4.8 | Fibrous; acicular; columnar; earthy; powder | Blackens fingers; often with psilomelane; darker than stibnite |
| Orth. | C, brachypinacoidal, perfect and prominent<br>Brittle; slightly sectile | 4.5 | Fibrous; columnar; bladed; prismatic | Prisms often bent and with long shining cleavage faces; sometimes iridescent. Surface tarnishes black |
| Isom. | C, not important<br>F, hackly<br>Slightly malleable | 7.3 | Octahedrons; hackly masses; arborescent; reticulated | Resembles tarnished silver; often with silver, copper, barite; cuts like lead |
| Orth. | C, imperfect<br>F, uneven<br>Very brittle | 6.3 | Compact; massive; crystals, short prisms | Often with other silver ores; also barite, quartz, galena |
| Mono. | C, indistinct<br>F, uneven<br>Brittle | 6.2 | Platy crystals; short prisms | Resembles stephanite. Often with ruby silver. Thin splinters may be red translucent |
| Isom. | C, cubic, perfect and prominent<br>Sectile to brittle | 7.5 | Cubes; cubo-octahedrons; granular; foliated | Often with sphalerite, pyrite, tetrahedrite, cerussite, anglesite, dolomite, calcite, fluorite; heavier than stibnite and never long prismatic cleavage |
| Orth. | C, indistinct<br>F, conchoidal or granular<br>Sectile | 5.7 | Compact; massive; crystals with deeply striated faces | Often coated with malachite; occurs with bornite, chalcopyrite, quartz, malachite, enargite |
| Orth. | C, prismatic and prominent<br>Brittle | 4.4 | Massive | Often with chalcocite, bornite, famatinite<br>Note cleavage |

| | Name. | Composition. | Color. | Streak. | Luster. | H. |
|---|---|---|---|---|---|---|
| COLOR DARK GRAY OR BLACK. | ARSENIC | As | Black | Dark gray | Metallic | 3.5 |
| | **TETRAHEDRITE**<br>TENNANTITE | $Cu_8Sb_2S_7$<br>$Cu_8As_2S_7$ | Dark lead- or steel-gray | Dark gray | Metallic | 3<br>4.5 |
| | **PSILOMELANE** | MnO, $MnO_2$, $H_2O$, etc. | Grayish black<br>Dull black | Brownish black | Submetallic | 5<br>6 |
| | WOLFRAMITE<br>HÜBNERITE | $(Fe,Mn)WO_4$<br>$MnWO_4$ | Black | Brownish black | Metallic<br>Submetallic | 5<br>5.5 |
| | ILMENITE<br>(Menaccanite) | $(FeTi)_2O_3$ | Iron-black | Brownish black | Metallic | 5.5<br>6 |
| | **MAGNETITE** | $Fe_3O_4$ | Iron-black | Iron-black | Metallic | 5.5<br>6.5 |
| | **FRANKLINITE** | $(Fe,Mn,Zn)_3O_4$ | Iron-black | Brownish black | Metallic | 5.5<br>6.5 |
| | COLUMBITE | $(Fe,Mn)(Nb,Ta)_2O_6$ | Pitch-black | Grayish black | Submetallic<br>Vitreous | 6 |
| COLOR METALLIC WHITE TO LIGHT GRAY. | **MOLYBDENITE** | $MoS_2$ | Bluish lead-gray | Lead-gray with often greenish tinge | Metallic | 1<br>1.5 |
| | **STIBNITE** | $Sb_2S_3$ | Light lead-gray | Dark lead-gray<br>Black | Metallic | 2 |
| | **GALENITE** | PbS | Lead-gray | Dark lead-gray<br>Black | Metallic | 2.5<br>3 |
| | ANTIMONY | Sb | Light steel-gray<br>Tin-white | Lead-gray | Metallic | 3<br>3 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Hex. | C, basal, not prominent<br>F, granular<br>Brittle | 6 | Round and reniform masses; granular | Usually black from tarnish. Tin-white on fresh fracture |
| Isom. | C, none<br>F, granular<br>Brittle | 4.4<br>5.1 | Compact; massive; tetrahedral crystals | Often in quartz with galena, chalcopyrite, sphalerite; sometimes with very brilliant luster |
| None | C, none<br>F, conchoidal and prominent<br>Tough to brittle | 3.7<br>4.7 | Impalpable; massive; stalactitic; botryoidal; rounded masses | Often with limonite, pyrolusite, manganite |
| Mono. | C, clinopinacoidal prominent<br>Brittle | 7.5 | Thick tabular crystals; massive | Heavy black masses or cleavage pieces |
| Hex. | C, none<br>F, conchoidal<br>Brittle | 4.5<br>5 | Grains and pebbles; black sand; platy; massive granular | Slightly magnetic to nonmagnetic. In black sands with magnetite |
| Isom. | C, not prominent<br>F, uneven<br>Brittle | 5.2 | Octahedrons; massive granular to compact; black sands | Strongly magnetic; often with quartz, feldspar, hornblende, chlorite; crystals usually very perfect |
| Isom. | C, none<br>F, uneven<br>Very brittle | 5.2 | Octahedrons, usually rounded; granular; massive | Usually with zincite, willemite, rhodonite, and calcite; magnetic, but not strongly like magnetite. Note associations |
| Orth. | C, not important<br>F, uneven<br>Brittle | 5.3<br>7.3 | Crystals, usually in parallel groups | Occurs in granite or pegmatite, often with albite, tourmaline, beryl |
| Hex. | C, basal, perfect and prominent<br>Sectile | 4.7 | Foliated masses; scales; flakes | Soft and greasy, like graphite; highly flexible; often with quartz |
| Orth. | C, brachypinacoidal very prominent<br>Brittle; slightly sectile | 4.5 | Prismatic; fibrous; columnar; bladed | Often in quartz with galenite, sphalerite, tetrahedrite |
| Isom. | C, cubic, perfect and prominent<br>Sectile to brittle | 7.5 | Cubes; cubo-octahedrons; granular; foliated; massive | Much heavier than stibnite and never long prismatic |
| Hex. | C, basal, prominent<br>Brittle | 6.7 | Massive; lamellar | Often with stibnite; usually coated with earthy white oxide of antimony |

| | Name. | Composition. | Color. | Streak. | Luster. | H. |
|---|---|---|---|---|---|---|
| COLOR METALLIC WHITE TO LIGHT GRAY. | ARSENIC | As | Light steel-gray on fresh fracture | Dark gray | Metallic | 3.5 |
| | **ARSENOPYRITE** | FeAsS | Light steel-gray<br>Tin-white, often with brassy or reddish tinge | Grayish black | Metallic | 5.5<br>6 |
| | SMALTITE<br>CHLOANTHITE | $CoAs_2$<br>$NiAs_2$ | Tin-white<br>Light steel-gray<br>Bluish gray | Grayish black | Metallic | 5.5<br>6 |
| | COBALTITE | CoAsS | Silver-white with usually copper-red tinge | Grayish black | Metallic | 5.5 |
| | **MARCASITE** | $FeS_2$ | Brassy steel-gray<br>Pale brass-yellow | Greenish black<br>Brownish black | Metallic | 6<br>6.5 |
| COLOR BRASS, BRONZE, COPPER-RED, BLUE, OR BROWN. | COVELLITE | CuS | Dark blue<br>Indigo blue | Black | Metallic | 1.5<br>2 |
| | **BORNITE** | $Cu_5FeS_4$ | Copper-brown<br>Horseflesh-brown<br>Blue | Grayish black | Metallic | 3 |
| | MILLERITE | NiS | Brass-yellow | Greenish black | Metallic | 3<br>3.5 |
| | **CHALCOPYRITE** | $CuFeS_2$ | Deep brass yellow | Greenish black | Metallic | 3.5<br>4 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Hex. | C, basal, not usually prominent<br>F, granular<br>Brittle | 6 | Rounded, reniform masses; granular | Usually tarnished dull black on surface |
| Orth. | C, not prominent<br>F, uneven<br>Very brittle | 6 | Compact massive; pointed pyramids with horizontally striated faces | Often with sphalerite, galena, quartz; sometimes with gold; whiter than pyrite or marcasite; more common than smaltite. Arsenic odor when broken |
| Isom. | C, not important<br>F, granular<br>Brittle | 6.5 | Compact; massive; reticulated | Often with copper-red niccolite, pink erythrite or green annabergite |
| Isom. | C, cubic, not prominent<br>Brittle | 6.3 | Crystals commonly; cubes; pyritohedrons; massive | Often with smaltite, niccolite; crystals usually tarnished to pale copper-red color |
| Orth. | C, not prominent<br>F, uneven<br>Brittle | 4.9 | Stalactitic with rough surfaces; coxcomb; radiate; columnar; low pyramids; massive | Never in cubes or pyritohedrons, and different in form from pyrite. Massive or granular marcasite is generally indistinguishable from pyrite |
| Hex. | C, basal and prominent<br>F, uneven<br>Brittle | 4.6 | Compact platy masses; granular; crusts | May occur with chalcocite, enargite, chalcopyrite |
| Isom. | C, not important<br>F, uneven<br>Brittle | 4.9<br>5.4 | Compact; massive | Usually tarnished to peacock colors; occurs with quartz, chalcocite, chalcopyrite |
| Hex. | C, perfect and prominent in crystals<br>Brittle | 5.3<br>5.6 | Acicular; capillary; hair tufts; compact fibrous layers | Always needle-like or fibrous; often in cavities in chert or red hematite, or coating pyrrhotite |
| Tetrag. | C, not important<br>F, uneven to conchoidal<br>Brittle | 4.2 | Massive; tetrahedral crystals | Often with pyrite, galena, sphalerite, tetrahedrite, chalcocite, dolomite, etc.; often tarnished peacock colors |

| | Name. | Composition. | Color. | Streak. | Luster. | H. |
|---|---|---|---|---|---|---|
| BRASS, BRONZE, COPPER-RED, OR BROWN. | **PYRRHOTITE** | $Fe_7S_8$ to $Fe_{11}S_{12}$ or $Fe_nS_{n+1}$ | Bronze-yellow Bronze-brown | Grayish black | Metallic | **3.5 4.5** |
| | PENTLANDITE | (Fe,Ni)S | Bronze-yellow | Black | Metallic | **3.5 4** |
| | NICCOLITE | NiAs | Pale copper-red | Brownish black | Metallic | **5 5.5** |
| | **PYRITE** | $FeS_2$ | Pale brass-yellow | Greenish black Brownish black | Metallic | **6 6.5** |
| | **MARCASITE** | $FeS_2$ | Pale brass-yellow | Greenish black Brownish black | Metallic | **6 6.5** |
| | | | **STREAK METALLIC WHITE** | | | |
| COLOR METALLIC WHITE OR LIGHT METALLIC GRAY. | MERCURY | Hg | Tin-white | | Metallic | |
| | SYLVANITE CALAVERITE | $(AuAg)Te_2$ | Silver- or tin-white; often with brassy tinge | Silver-white | Metallic | **1.5 2** |
| | BISMUTH | Bi | Reddish white to light copper-red | Silver-white Lead-gray | Metallic | **2 2.5** |
| | **SILVER** | Ag | Silver-white | Silver-white | Metallic | **2.5** |
| | ANTIMONY | Sb | Tin-white Silver-white | Silver-white | Metallic | **3 3.5** |
| | ARSENIC | As | Tin-white Light lead- or steel-gray | Tin-white | Metallic | |
| | PLATINUM PLATINIRIDIUM | Pt PtIr | Tin-white Light steel-gray | Light steel-gray | Metallic | **4 4.5** |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Hex. | C, not important<br>F, uneven<br>Brittle | 4.6 | Massive; granular; occasional crystals | Usually slightly magnetic; surface often tarnished dark bronze-brown. Only magnetic sulphide |
| Isom. | C, octahedral, not usually prominent<br>Brittle | 4.6<br>5.1 | Massive and granular | Resembles and is usually with pyrrhotite. Nonmagnetic |
| Hex. | C, none<br>F, uneven<br>Brittle | 7.5 | Compact; impalpable massive | Usually with smaltite<br>Very heavy |
| Isom. | C, indistinct<br>F, uneven<br>Brittle | 5 | Cubes; pyritohedrons; octahedrons; massive; granular | Very common; associated with all sulphides and in all rocks. Often in crystals |
| Orth. | C, not important<br>F, uneven<br>Brittle | 4.9 | Coxcomb and curved dome shapes; stalactitic with rough faces | Distinguished from pyrite by form generally. Usually indistinguishable from pyrite when massive or granular |
| **TO LIGHT LEAD- OR STEEL-GRAY.** | | | | |
| | | 13.6 | Liquid globules | Occurs as small globules on cinnabar |
| Mono. | C, clinopinacoidal, perfect, prominent<br>F, coarse granular<br>Brittle | 9.9<br>8.3 | Massive; crystals with deeply striated faces | Often in gray phonolite rock with purple fluorite; also in schist |
| Hex. | C, basal, perfect and prominent<br>Brittle | 9.7 | Reticulated; embedded lenticular crystals; massive | Often as lenticular crystals or grains in quartz. Heavy |
| Isom. | C, none<br>F, hackly<br>Malleable | 10.1<br>11.1 | Wires; arborescent; massive; filiform | Usually tarnished on surface to brown or black; often with barite, calcite, other silver ores |
| Hex. | C, basal, prominent<br>Brittle | 6.7 | Massive; lamellar | Sometimes with stibnite; usually coated with whitish oxide of antimony |
| Hex. | C, basal, not usually prominent<br>F, granular<br>Brittle | 5.6 | Rounded reniform masses; granular | Usually tarnished dull black on surface |
| Isom. | C, none<br>F, hackly<br>Malleable | 14<br>19 | Nuggets; grains | In gold-bearing sands |

COLOR RED OR BROWN.

| Name. | Composition. | Color. | Streak. | Luster. | H. |
|---|---|---|---|---|---|
| **BAUXITE** | $Al_2O_3 \cdot 2H_2O$ | Brown | Reddish brown | Earthy Dull | 1 2 |
| **HEMATITE** | $Fe_2O_3$ | Brownish red Cherry-red Black | Dark red Cherry-red | Earthy Dull Metallic | 1 4 |
| ERYTHRITE | $Co_3As_2O_8 \cdot 8H_2O$ | Peach-red Crimson | Pale-red | Earthy Vitreous | 1 2.5 |
| WAD | $MnO_2, H_2O$ | Dark brown Black | Dark reddish brown | Earthy Dull | 1 3 |
| **CINNABAR** | HgS | Scarlet red Vermilion Dark red | Scarlet Vermilion | Adamantine | 2 2.5 |
| PROUSTITE | $Ag_3AsS_3$ | Scarlet Vermilion | Scarlet | Adamantine | 2 2.5 |
| PYRARGYRITE | $Ag_3SbS_3$ | Dark red | Cherry-red Dark red | Adamantine | 2.5 3 |
| **COPPER** | Cu | Copper-red | Copper-red | Metallic | 2.5 3 |
| **SPHALERITE** | ZnS | Dark brown | Reddish brown | Resinous Vitreous | 3.5 4 |
| **CUPRITE** | $Cu_2O$ | Dark red Ruby red | Cochineal-red Brick-red Crimson-red | Adamantine Earthy | 3.5 4 |
| **HEMATITE** | $Fe_2O_3$ | Dark brownish red | Brownish red Cherry red | Submetallic | 4.5 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| | C, none<br>F, earthy | 2.5 | Claylike masses with small rounded concretions; pisolitic | Clay odor; distinguished from clay by pisolitic structure. Color due to iron oxide |
| | C, none<br>F, earthy<br>Scaly | 5 | Earthy masses; oölitic; powder micaceous | Red ochre; often red clay. Brilliant black micaceous variety is called specular hematite |
| Mono. | C, not important<br>F, usually earthy | 2.9 | Earthy; crusts; rarely in crystals | Occurs with cobalt and nickel ores as coatings and crusts |
| Amorph. | C, none<br>F, earthy<br>Brittle | 4 | Earthy masses; powder concretions | Often with psilomelane, limonite, malachite, azurite |
| Hex. | C, prismatic, not important<br>F, uneven<br>Sectile | 8<br>8.2 | Granular; crystals; powder; massive; compact | Occurs with marcasite, chalcedony, quartz, sulphur; very heavy; often mixed with siliceous rock and apparently hard |
| Hex. | C, rhombohedral, not prominent<br>Brittle | 5.6 | Crystals; red bands or streaks in rock | Light ruby silver ore; often with gray pyrargyrite |
| Hex. | C, indistinct<br>F, small conchoidal<br>Sectile | 5.5 | Massive; granular; small crystals | Generally as dark gray and dark red bands in silver ores. Grades into proustite |
| Isom. | C, none<br>F, hackly<br>Malleable | 8.8 | Hackly masses; sheets; wires, arborescent forms | Usually tarnished black on surface; often with calcite, cuprite, malachite |
| Isom. | C, dodecahedral, perfect and prominent<br>Brittle | 4 | Massive; crystals | Often with galena, pyrite, arsenopyrite, etc. In limestone and chert |
| Isom. | C, poor<br>F, uneven<br>Brittle | 5.9 | Massive; compact; crystals; octahedrons; cubes | Usually with malachite, copper |
| Hex. | C, none<br>F, uneven; splintery<br>Brittle | 5 | Massive; reniform, mamillary; botryoidal; splintery; oölitic | Massive red hematite |

| | Name. | Composition. | Color. | Streak. | Luster. | H. |
|---|---|---|---|---|---|---|
| COLOR RED OR BROWN. | TURGITE | $2Fe_2O_3 \cdot H_2O$ | Brown | Reddish brown | Submetallic | 5 6 |
| | JASPER | $SiO_2$ | Dark red Brownish-red | Dark red | Vitreous | 7 |
| COLOR DARK GRAY OR BLACK. | **PYRARGYRITE** | $Ag_3SbS_3$ | Dark steel-gray | Purple-red Cherry-red | Metallic | 2.5 |
| | **TETRAHEDRITE** | $Cu_8Sb_2S_7$ | Dard lead or steel gray | Cherry-red Dark red brown | Metallic | 3 4.5 |
| | **HEMATITE** | $Fe_2O_3$ | Dark steel-gray Iron-black | Brownish red | Metallic Brilliant | 2.5 4 |
| | **SPHALERITE** | ZnS | Brownish black | Dark brown | Resinous Submetallic | 3.5 4 |
| | MANGANITE | $Mn_2O_3 \cdot H_2O$ | Iron-black Dark steel-gray | Dark red-dish brown | Metallic | 4 |
| | WOLFRAMITE HÜBNERITE | $(Fe,Mn)WO_4$ $MnWO_4$ | Dark gray-ish or brownish black | Dark red-dish brown | Submetallic Metallic | 5 5.5 |
| | **PSILOMELANE** | $MnO,MnO_2,H_2O$ | Dull black | Very dark brown | Submetallic Dull | 5 6 |
| | **HEMATITE** MARTITE | $Fe_2O_3$ | Iron-black Dark steel-gray | Cherry-red Brownish red Red-brown | Metallic | 5.5 6.5 |
| | ILMENITE | $(Fe,Ti)_2O_3$ | Iron-black | Very dark brown | Metallic | 5.5 6 |
| | FRANKLINITE | $(Fe,Mn,Zn)_3O_4$ | Iron-black | Dark red-dish brown Blackish brown | Metallic | 5.5 6.5 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| | C, none<br>F, splintery<br>Brittle | 4.2<br>4.4 | Compact; fibrous: massive; botryoidal; earthy | Resembles limonite; distinguished by streak; fibers often with satin-like luster |
| Hex. | C, none<br>F, conchoidal | 2.6 | Very dense cryptocrystalline masses | Color and streak due to hematite |
| Hex. | C, not important<br>F, uneven<br>Brittle | 5.8 | Massive; granular; bands and streaks in rock | Usually as gray bands mixed with red, in quartz rock; dark ruby silver ore |
| Isom. | C, none<br>F, uneven<br>Brittle | 4.4<br>5.1 | Massive; tetrahedral crystals | Often has brilliant luster with brassy tinge; in quartz with sulphides |
| Hex. | C, micaceous<br>Brittle | 4.9<br>5.3 | Foliated; platy; micaceous | Specular hematite; very bright sparkling plates or scales |
| Isom. | C, dodecahedral, prominent<br>Brittle | 4 | Massive | Often with galenite, pyrite, chalcopyrite, tetrahedrite |
| Orth. | C, brachypinacoidal, prominent<br>Brittle | 4.4 | Prisms; columnar; acicular | Prisms often in bunches with prism faces deeply striated vertically; occurs with pyrolusite |
| Mono. | C, clinopinacoidal, perfect and prominent<br>Brittle | 7.5 | Thick tabular crystals; massive; compact | Often with cassiterite, quartz, fluorite<br>Hübnerite is red in thin splinters |
| | C, none<br>F, conchoidal<br>Tough to brittle | 3.7<br>4.7 | Impalpable; massive; stalactitic; botryoidal, round masses | Often with powdery or brilliant needles of pyrolusite |
| Hex. | C, none<br>F, uneven<br>Brittle | 4.9<br>5.3 | Massive; granular; foliated; crystals; scales; micaceous | Crystals often have an iridescent tarnish; fine scaly specular variety seems soft. Martite, a pseudomorph after magnetite is partly magnetite and partly hematite |
| Hex. | C, none<br>F, conchoidal<br>Brittle | 4.5<br>5 | Rounded pebbles; sand; plates; massive | Sometimes slightly magnetic |
| Isom. | C, none<br>F, uneven<br>Very brittle | 5<br>5.2 | Rounded crystals; Octahedrons; granular masses | Usually with zincite, willemite, calcite; magnetic but not so strongly as magnetite<br>Note associations |

| | Name. | Composition. | Color. | Streak. | Luster. | H. |
|---|---|---|---|---|---|---|
| BLACK. | COLUMBITE | $(Fe,Mn)(Nb,Ta)_2O_6$ | Pitch-black | Dark brown | Submetallic Vitreous | 6 |
| | CASSITERITE | $SnO_2$ | Black Brownish black | Dark brown | Submetallic to Metallic | 6 7 |
| | | | | | **STREAK YELLOW** | |
| COLOR RED. | REALGAR | AsS | Bright red Orange-red | Orange yellow | Adamantine Resinous Vitreous | 1.5 2 |
| | ZINCITE | ZnO | Dark red Blood-red | Orange-yellow | Vitreous | 4 4.5 |
| COLOR YELLOW. | ORPIMENT | $As_2S_3$ | Lemon-yellow | Lemon-yellow | Adamantine Resinous Pearly | 1.5 2 |
| | REALGAR | AsS | Orange-yellow | Orange-yellow | Resinous Vitreous | 1.5 2 |
| | SULPHUR | S | Sulphur-yellow Honey-yellow Straw-yellow | Pale yellow | Resinous Greasy Vitreous | 1.5 2.5 |
| | COPIAPITE | $2Fe_2O_3 5SO_3 \cdot 18H_2O$ | Sulphur-yellow | Pale yellow | Vitreous | 1.5 2.5 |
| | LIMONITE | $2Fe_2O_3 \cdot 3H_2O$ | Yellow | Yellow Brown | Earthy Dull | 1 4 |
| | GOLD | Au | Golden yellow | Golden yellow | Metallic | 2.5 3 |
| | SPHALERITE | ZnS | Brownish yellow | Pale yellow | Resinous | 3.5 4 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Orth. | C, not important<br>F, uneven<br>Brittle | 5.3<br>7.3 | Crystals, usually in parallel groups | Occurs in granite or pegmatite, often with albite, tourmaline, beryl |
| Tetrag. | C, imperfect<br>F, uneven<br>Brittle | 6.8<br>7.1 | Massive | Often in quartz-mica rock with wolframite, fluorite |
| **OR YELLOW-BROWN.** | | | | |
| Mono. | C, clinopinacoidal, not prominent<br>F, conchoidal<br>Sectile | 3.5 | Massive; granular; crystals | Often with orpiment disseminated in siliceous rock and often apparently hard. Occasionally with stibnite |
| Hex. | C, basal, perfect and prominent<br>F, uneven<br>Brittle | 5.4<br>5.7 | Massive; lamellar; granular | Occurs with franklinite willemite, calcite<br>Note associations |
| Orth. | C, brachypinacoidal, perfect and prominent<br>Sectile; flexible | 3.5 | Foliated; plates massive | Usually with realgar |
| Mono. | C, clinopinacoidal, not prominent<br>F, conchoidal<br>Brittle; sectile | 3.5 | Crystals; massive; granular | Often with orpiment or finely mixed quartz |
| Orth. | C, indistinct<br>F, conchoidal<br>Brittle | 2 | Crystals; pyramids; crusts | May occur with celestite, aragonite, limestone, cinnabar, gypsum |
| Mono. | C, indistinct<br>F, earthy, scaly | 2.1 | Scaly; granular; short fibers | Metallic taste like ink. Often with pyrite and pyrrhotite as an oxidation product |
| | C, none<br>F, earthy | 3.6 | Earthy masses; ochre powder | Yellow ochre; often yellow clay |
| Isom. | C, none<br>F, hackly<br>Highly malleable | 15.6<br>19.3 | Scales; flakes; leaves; grains; wires; nuggets | Usually in quartz, conglomerates, or schists; sometimes with pyrite or arsenopyrite |
| Isom. | C, dodecahedral; prominent<br>F, uneven<br>Brittle | 4 | Massive; cleavage masses; crystals | Usually with galena, pyrite, chalcopyrite, tetrahedrite, quartz, calcite, dolomite |

| | Name. | Composition. | Color. | Streak. | Luster. | H. |
|---|---|---|---|---|---|---|
| YELLOW | PYROMORPHITE | $(PbCl)Pb_4(PO_4)_3$ | Greenish yellow<br>Wax-yellow<br>Brown | Greenish yellow | Adamantine | 3.5<br>4 |
| COLOR BROWN OR BLACK. | BAUXITE | $Al_2O_3 \cdot 2H_2O$ | Brown | Brownish yellow | Earthy<br>Dull | 1<br>3 |
| | LIMONITE | $2Fe_2O_3 \cdot 3H_2O$ | Brown | Brownish yellow<br>Yellowish brown | Earthy<br>Dull | 1<br>4 |
| | SPHALERITE | $ZnS$ | Brown<br>Brownish black | Brownish yellow | Resinous | 3.5<br>4 |
| | SIDERITE | $FeCO_3$ | Pale brown<br>Grayish brown<br>Dark brown | Pale yellow<br>Yellowish brown | Vitreous | 3.5<br>4 |
| | GOETHITE | $Fe_2O_3 \cdot H_2O$ | Yellowish brown | Yellowish brown<br>Brownish yellow | Submetallic | 5<br>5.5 |
| | LIMONITE | $2Fe_2O_3 \cdot 3H_2O$ | Yellowish brown<br>Dark brown | Brownish yellow<br>Yellow-brown | Submetallic<br>Dull | 5<br>5.5 |
| | CHROMITE | $FeCr_2O_4$ | Black | Grayish brown<br>Yellowish-brown | Submetallic<br>Pitchlike | 5.5 |
| | BROOKITE | $TiO_2$ | Dark brownish black | Pale yellow<br>Grayish brown | Submetallic<br>Metallic | 5.5<br>6 |
| | RUTILE | $TiO_2$ | Reddish brown<br>Black | Pale yellowish brown | Adamantine<br>Metallic | 6<br>6.5 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Hex. | C, not prominent<br>F, uneven<br>Brittle | 6.5<br>7.1 | Small hexagonal prisms; massive | Often with galena, cerussite, anglesite, mimetite |
| | C, none<br>F, earthy | 2.5 | Clay-like masses; pisolitic | Clay odor; distinguished from kaolinite (clay) by pisolitic structure. Color due to iron oxide |
| | C, none<br>F, earthy | 3.6 | Massive; earthy | Brown ochre or brown clay (kaolinite) |
| Isom. | C, dodecahedral, prominent<br>F, uneven<br>Brittle | 4 | Massive; cleavage masses; crystals | Common color; occurs with galena in chert; also with many sulphides<br>Note luster |
| Hex. | C, rhombohedral, perfect and prominent<br>Brittle | 3.8 | Rhombohedrons; cleavage masses; crystals with curved faces | Often with cryolite, quartz, hematite, fluorite<br>Dark color due to oxidation |
| Orth. | C, brachypinacoidal, prominent<br>F, uneven<br>Brittle | 4<br>4.4 | Acicular; stalactitic; radiate; fibrous | Often in cavities in limonite or hematite; distinguished from limonite by crystals and cleavage |
| | C, none<br>F, uneven<br>Brittle | 3.6<br>4 | Compact; massive: stalactitic; botryoidal; columnar | Often in cubes as an alteration from pyrite; very common iron oxide; botryoidal and mammillary masses often have black varnish-like surfaces |
| Isom. | C, none<br>F, uneven<br>Brittle | 4.3<br>4.5 | Massive | Often coated with green garnets or green chlorite; often with serpentine |
| Orth. | C, not important<br>F, uneven<br>Brittle | 3.8<br>4 | Square pyramids; hexagonal shaped pyramids | Always in crystals; faces deeply striated; not twinned like rutile |
| Tetrag. | C, not important<br>F, uneven<br>Brittle | 4.2 | Twinned crystals; long acicular crystals | Faces deeply striated; knee-shaped twins; often in quartz |

| | Name. | Composition. | Color. | Streak. | Luster. | H. |
|---|---|---|---|---|---|---|
| COLOR BR. OR BL. | **CASSITERITE** | $SnO_2$ | Black<br>Reddish brown<br>Yellowish brown<br>Pale yellow | Pale yellow<br>Pale grayish brown | Submetallic | 6<br>7 |
| COLOR GREEN. | **PYROMORPHITE** | $(Pb,Cl)Pb_4(PO_4)_3$ | Yellowish green<br>Grass-green | Pale greenish yellow | Adamantine<br>Vitreous | 3.5<br>4 |
| | **EPIDOTE** | $HCa_2(Al,Fe)_2Si_3O_{13}$ | Yellowish green<br>Deep green<br>Oil-green | Pale yellow | Vitreous | 6<br>7 |

**STREAK BLUE**

| | | | | | | |
|---|---|---|---|---|---|---|
| COLOR BLUE, GREEN, OR BLACK. | ANNABERGITE | $Ni_3As_2O_8 \cdot 8H_2O$ | Apple-green | Pale green | Vitreous<br>Earthy | 1 |
| | VIVIANITE | $Fe_3P_2O_8 \cdot 8H_2O$ | Dark blue-green<br>Indigo-blue | Indigo-blue | Vitreous<br>Earthy | 1.5<br>2 |
| | **CHLORITE**<br>PROCHLORITE<br>CLINOCHLORE | $(Mg,Fe)_5Al_2Si_3O_{14} \cdot 4H_2O$ | Dark green | Grayish green | Vitreous<br>Pearly | 1.5<br>2.5 |
| | GLAUCONITE | $FeKSi_2O_6 \cdot H_2O$ | Dark green<br>Grass-green | Pale green | Vitreous<br>Dull | 1<br>2 |
| | LINARITE | $(Cu,Pb)SO_4 \cdot (Cu,Pb)(OH)_2$ | Deep azure-blue | Smalt-blue<br>Pale blue | Adamantine<br>Vitreous | 2.5 |
| | **CHRYSOCOLLA** | $CuSiO_3 \cdot 2H_2O$ | Bluish green<br>Greenish blue | Pale green<br>Pale blue | Vitreous<br>Greasy<br>Earthy | 2<br>4 |
| | BROCHANTITE | $CuSO_4 \cdot 3Cu(OH)_2$ | Dark green<br>Emerald green | Pale green | Vitreous | 3.5 |
| | **AZURITE** | $2CuCO_3 \cdot Cu(OH)_2$ | Azure-blue | Smalt-blue | Vitreous<br>Velvety | 3.5<br>4 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Tetrag. | C, not important<br>F, uneven<br>Brittle | 6.8<br>7.1 | Pebbles with concentric structure; crystals; massive | Stream tin; wood tin<br>Heavy masses |
| Hex. | C, not important<br>F, uneven<br>Brittle | 6.5<br>7.1 | Small hexagonal prisms; drusy crusts; massive | Very heavy; usually with galena |
| Mono. | C, basal, perfect and usually prominent | 3.2<br>3.5 | Prismatic; columnar; reticulated masses | Often in quartz and schists; also with calcite |
| **OR GREEN.** | | | | |
| Mono. | C, none<br>F, earthy | | Fine capillary coatings | Occurs with erythrite as coatings and crusts on cobalt and nickel ores |
| Mono. | C, clinopinacoidal, perfect in crystals<br>Brittle | 2.6 | Slender prismatic; acicular; earthy | Often as crystals in pyrrhotite; as earthy round masses in clay or sandstone |
| Mono. | C, basal, perfect and prominent<br>Tough to brittle | 2.8 | Micaceous scaly flakes; compact scaly masses | Highly flexible but not elastic, like mica; often altered from biotite |
| Mono. | C, none<br>F, earthy | 2.2 | Green sand | Dark green scaly and earthy grains in sandstone and marl. Resembles chlorite somewhat |
| Mono. | C, orthopinacoidal, usually prominent<br>Brittle | 5.4 | Columnar; fibrous; long prisms sometimes radiate | Usually with galenite; heavier than azurite, and shows cleavage faces |
| Amorph. | C, none<br>F, uneven<br>Brittle | 2<br>2.3 | Massive; stains; earthy | Usually with copper ore: darker and glassier bluish green than malachite, and never fibrous |
| Ortho. | C, brachypinacoidal prominent<br>Brittle | 3.8 | Small prisms and drusy crusts | Very dark green. More crystalline and not banded like malachite |
| Mono. | C, not prominent<br>Brittle | 3.8 | Crystals; fibrous; acicular | Usually with malachite and often with limonite and wad |

COLOR BLUE, GREEN, OR BLACK.

| Name. | Composition. | Color. | Streak. | Luster. | H. |
|---|---|---|---|---|---|
| **MALACHITE** | $CuCO_3 \cdot Cu(OH)_2$ | Bright green<br>Emerald-green<br>Dark green | Emerald-green | Vitreous<br>Silky<br>Velvety<br>Dull | 3.5<br>4 |
| ALABANDITE | MnS | Black | Dark grayish green<br>Olive green | Submetallic | 3.5<br>4 |
| LAZURITE<br>LAPIS LAZULI | $Na_8Al_3S_3(SiO_4)_3$ | Azure-blue<br>Ultramarine blue | Pale blue | Vitreous<br>Greasy | 5<br>5.5 |
| **AUGITE** | $MgCa_2Fe(SiO_3)_4$ with Al and Fe | Greenish black<br>Blackish green | Pale grayish green | Vitreous | 5<br>6 |
| **HORNBLENDE** | $Mg_3Ca_2Fe(SiO_3)_6$ with Al and Fe | Greenish black<br>Blackish green<br>Black | Pale grayish green | Vitreous<br>Silky | 5<br>6 |
| GLAUCOPHANE | Silicate of Na, Al, Mg, Fe | Lavender-blue<br>Blackish blue | Grayish blue | Vitreous<br>Pearly | 6<br>6.5 |

**STREAK UNCOLORED, WHITE,**

COLOR YELLOW OR BROWN.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| CERARGYRITE | AgCl | Dark gray<br>Dark brown | Waxy<br>Adamantine | 1<br>1.5 |
| **BAUXITE** | $Al_2O_3 \cdot 3H_2O$ | Yellow to brown | Earthy<br>Dull | 1.5<br>3 |
| **KAOLINITE**<br>(Clay) | $H_4Al_2Si_2O_9$ | Yellow to brown | Earthy<br>Dull | 1.5<br>2.5 |
| **GYPSUM** | $CaSO_4 \cdot 2H_2O$ | Yellow to brown | Vitreous<br>Silky<br>Dull | 1.5<br>2 |
| **SULPHUR** | S | Sulphur-yellow<br>Honey-yellow<br>Brown | Vitreous<br>Greasy | 1.5<br>2 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Mono. | C, not prominent<br>F, uneven;<br>Brittle | 4 | Fibrous; banded; stalactitic; botryoidal; powder | Often with cuprite, copper, chalcocite, chalcopyrite; often as green stains in ore rocks |
| Isom. | C, not prominent<br>F, uneven<br>Brittle | 4 | Massive | Sometimes with rhodochrosite, pyrite, argentite, galena; surface usually tarnished brown |
| Isom. | C, not important<br>Brittle | 2.4 | Massive; disseminated in rock | Often with calcite and pyrite |
| Mono. | C, prismatic, not usually prominent<br>Cleavage angle 87°<br>Brittle | 3.2<br>3.6 | Almost square prisms; massive | Distinguished from hornblende by cleavage angle; also more often in crystals |
| Mono. | C, prismatic and very prominent<br>Cleavage angle 124°<br>Brittle | 2.9<br>3.4 | Massive; crystals rare | Usually with bright cleavage faces having a fibrous appearance |
| Mono. | C, prismatic, perfect<br>Brittle | 3.1 | Fibrous; columnar; reticulated | Usually forms schists; a blue hornblende |

**OR LIGHT GRAY.**

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Isom. | C, none<br>Very sectile | 5.5 | Thin crusts; coatings; massive | Cuts like wax; often with silver ores |
| | C, none<br>F, earthy | 2.5 | Compact earthy; pisolitic | Clay odor; distinguished from kaolinite (clay) by pisolitic structure |
| Mono. | C, none<br>F, earthy | 2.6 | Compact earthy; soapy; friable | Clay odor; massive clay; occasionally soapy feel |
| Mono. | C, pinacoidal<br>Brittle | 2.3 | Fibrous; columnar; granular; compact massive | Ferruginous gypsum; cleavage very prominent in transparent selenite variety |
| Orth. | C, not important<br>F, uneven<br>Brittle | 2 | Crystals; pyramids; crusts. | Often with limestone, celestite, aragonite, cinnabar |

COLOR YELLOW OR BROWN.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| **CHLORITE**<br>PROCHLORITE<br>CLINOCHLORE<br>PENNINITE, etc. | $(Mg,Fe)_5Al_2Si_3O_{14}\cdot 4H_2O$ | Dark yellowish brown<br>Greenish brown | Vitreous<br>Pearly | 1.5<br>2.5 |
| **BIOTITE** | $(HK)_2(Mg,Fe)_2(Al,Fe)_2(SiO_4)_3$ | Dark brown<br>Greenish brown | Pearly to Vitreous | 2.5<br>3 |
| **PHLOGOPITE** | $H_2KMg_3Al(SiO_4)_3$ | Light brown<br>Cinnamon-brown | Pearly<br>Vitreous | 2.5<br>3 |
| **HALITE** | NaCl | Light yellow or brown | Vitrecus | 2.5 |
| CRYOLITE | $Na_3AlF_6$ | Grayish brown | Vitreous<br>Icy | 2.5<br>3 |
| **CALCITE** | $CaCO_3$ | Honey-yellow<br>Light to dark brown | Vitreous | 3 |
| **BARITE** | $BaSO_4$ | Lemon-yellow<br>Yellowish brown | Vitreous | 2.5<br>3.5 |
| **SERPENTINE** | $H_4Mg_3Si_2O_9$ | Greenish brown<br>Yellowish brown | Greasy<br>Vitreous | 2.5<br>4 |
| STRONTIANITE | $SrCO_3$ | Light brown | Vitreous | 3<br>3.5 |
| WULFENITE | $PbMoO_4$ | Lemon-yellow<br>Orange-yellow | Greasy<br>Adamantine | 3 |
| MIMETITE | $(PbCl)Pb_4(AsO_4)_3$ | Brownish yellow<br>Yellow-brown | Adamantine<br>Greasy | 3.5 |
| **PYROMORPHITE** | $(PbCl)Pb_4(PO_4)_3$ | Greenish yellow<br>Yellowish brown | Greasy<br>Adamantine | 3.5<br>4 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Mono. | C, basal, perfect and prominent<br>Tough | 2.9 | Micaceous; scales; flakes; compact scaly masses | Highly flexible but not elastic, like the micas; often an altered biotite |
| Mono. | C, basal, perfect and very prominent<br>Tough | 2.7<br>3.1 | Mica plates; scales; flakes | Dark color even in thinnest plates; flexible and elastic; black mica |
| Mono. | C, basal, perfect and prominent<br>Tough | 2.8 | Micaceous; scales; flakes; sheets | Lighter brown than biotite; almost colorless in thin sections; brown mica |
| Isom. | C, cubic, perfect and prominent<br>Brittle | 2.1<br>2.6 | Cubes; massive; granular | Tastes salt |
| Mono. | C, basal, prominent, and pinacoidal not so good | 3 | Massive | Three cleavages almost at right angles, making cubes; usually with siderite |
| Hex. | C, rhombohedral, very prominent<br>Brittle | 2.7 | Rhombohedrons; scalenohedrons; granular; massive | Rhombohedral cleavage very characteristic; very common mineral |
| Orth. | C, basal and prismatic, perfect and prominent | 4.3<br>4.6 | Massive; platy crystals | Heavy, vitreous mineral; often with galena |
| Mono. | C, not important<br>Brittle | 2.6 | Massive; compact | Very smooth feel, almost greasy |
| Orth. | C, prismatic, not prominent<br>Brittle | 3.7 | Columnar masses; coarse granular | Heavier than brown calcite |
| Orth. | C, not prominent<br>F, conchoidal<br>Very brittle | 6.5 | Massive; crusts | Usually with galenite or angiesite; very heavy |
| Tetrag. | C, not prominent<br>Brittle | 6.7<br>7 | Square plates; thin plates and tables | Often with vanadinite or galenite |
| Hex. | C, not prominent<br>Brittle | 7<br>7.2 | Rounded aggregates of plates; small crystals | Often with pyromorphite, galena |
| Hex. | C, none<br>Brittle | 6.5<br>7.1 | Short hexagonal prisms; columnar masses | Often with galena, cerussite, anglesite; crystal faces deeply striated vertically |

COLOR YELLOW OR BROWN.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| ARAGONITE | $CaCO_3$ | Honey-yellow<br>Yellow-brown | Vitreous<br>Glassy | 3.5<br>4 |
| STILBITE | $(Na_2Ca)Al_2Si_6O_{10}.6H_2O$ | Yellowish brown<br>Light brown | Vitreous<br>Silky | 3.5<br>4 |
| DOLOMITE | $(CaMg)CO_3$ | Yellowish brown<br>Grayish brown | Vitreous | 3.5<br>4 |
| SIDERITE | $FeCO_3$ | Grayish brown<br>Dark brown | Vitreous<br>Pearly | 3.5<br>4 |
| SPHALERITE | $ZnS$ | Honey-yellow<br>Yellowish brown<br>Reddish brown | Resinous | 3.5<br>4 |
| FLUORITE | $CaF_2$ | Lemon-yellow<br>Pale yellow,<br>Yellowish brown | Vitreous<br>Glassy | 4 |
| SCHEELITE | $CaWO_4$ | Yellowish brown<br>Grayish brown | Greasy<br>Adamantine | 4.5<br>5 |
| CALAMINE | $H_2Zn_2SiO_5$ | Pale brown | Vitreous | 4.5<br>5 |
| SMITHSONITE | $ZnCO_3$ | Yellowish brown | Vitreous | 5 |
| APATITE | $(CaF)Ca_4(PO_4)_3$<br>or $(CaCl)Ca_4(PO_4)_3$ | Brown<br>Greenish brown | Vitreous<br>Greasy | 5 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Orth. | C, not prominent<br>Brittle | 2.9 | Stalactitic; banded; massive | Differs from calcite in not having prominent cleavage |
| Mono. | C, clinopinacoidal<br>Brittle | 2<br>2.2 | Columnar; sheaf-like; fibrous | Often in cavities in lava rocks, with chabazite, heulandite, analcite |
| Hex. | C, rhombohedral, not prominent | 2.9 | Massive | Harder than calcite |
| Hex. | C, rhombohedral, perfect and very prominent | 3.8 | Rhombohedrons with curved faces; saddle-shaped crystals; massive | Often in cryolite; more glassy than sphalerite<br>Dark color due to oxidation |
| Isom. | C, dodecahedral, very prominent | 3.9<br>4.1 | Massive | Resinous cleavage faces characteristic; often with galena, tetrahedrite, etc. |
| Isom. | C, octahedral, perfect and prominent<br>Very brittle | 3.1 | Cubes; granular, massive | Often with pyrite, galena, and sulphides |
| Tetrag. | C, not prominent<br>Brittle | 5.9<br>6.1 | Crystals; pyramids; massive | Often with wolframite, cassiterite; very heavy masses |
| Orth. | C, prismatic, prominent | 3.5 | Drusy coatings; small crystals fibrous layers | Often with smithsonite on yellow earthy masses |
| Hex. | C, rhombohedral, not prominent | 4.3<br>4.5 | Small rhombohedral crystals; drusy crystals; bone-like masses | Dry bone; often with the silicate calamine; also with sphalerite |
| Hex. | C, basal, imperfect, not prominent<br>Brittle | 3.2 | Hexagonal prisms; granular | Green and brown colors often intermixed; crystals often have fused and oily appearance |

COLOR YELLOW OR BROWN.

| | Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|---|
| | MONAZITE | $(Ce,La,Di,Th)PO_4$ | Honey-yellow<br>Brown | Adamantine<br>Vitreous | 5<br>5.5 |
| | TITANITE | $CaTiSiO_5$ | Dark brown<br>Brownish yellow | Adamantine<br>Greasy<br>Vitreous | 5<br>5.5 |
| | WILLEMITE<br>TROOSTITE | $Zn_2SiO_4$ | Greenish yellow<br>Reddish brown | Vitreous | 5.5 |
| | CANCRINITE | $H_6Na_6Ca(NaCO_3)_2$<br>$Al_6(SiO_4)_9$ | Lemon-yellow | Greasy<br>Vitreous | 5<br>6 |
| | OPAL | $SiO_2 \cdot nH_2O$ | Yellow<br>Brown | Waxy<br>Vitreous | 5.5<br>6.5 |
| PYROXENE | ENSTATITE | $MgSiO_3$ | Grayish brown<br>Greenish brown | Vitreous<br>Pearly | 5.5 |
| PYROXENE | BRONZITE | $(Mg,Fe)SiO_3$ | Bronze-brown | Vitreous<br>Bronzy | 5<br>6 |
| PYROXENE | HYPERSTHENE | $(Fe,Mg)SiO_3$ | Dark brown<br>Blackish brown | Bronze-metallic<br>Vitreous<br>Pearly | 5<br>6 |
| PYROXENE | AUGITE | Silicate of Ca, Mg, Al, and Fe, chiefly | Dark brown | Vitreous | 5<br>6 |
| AMPHIBOLE | ANTHOPHYLLITE | $(Mg,Fe)SiO_3$ | Light grayish brown<br>Brownish gray<br>Greenish gray | Vitreous<br>Pearly | 5.5<br>6 |
| AMPHIBOLE | TREMOLITE | $CaMg_3(SiO_3)_4$ | Grayish brown | Vitreous<br>Silky | 5<br>6 |
| AMPHIBOLE | HORNBLENDE | $Ca(MgFe)_3(SiO_3)_4$ with $(MgFe)_2(AlFe)_4Si_2O_{12}$ and $Na_2Al_2(SiO_3)_4$ | Dark reddish brown | Vitreous | 5<br>6 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Mono. | C, basal, not prominent<br>Brittle | 5<br>5.5 | Yellow sand; brown crystals | Commonly as yellow sand; crystals rare |
| Mono. | C, indistinct usually<br>Brittle | 3.5 | Flat wedge-shaped crystals; massive | Often in syenitic rocks; often with hornblende and magnetite; masses show cleavage |
| Hex. | C, basal, sometimes prominent | 3.9<br>4.1 | Crystals; granular; massive | Often in calcite with zincite, franklinite |
| Hex. | C, prismatic not prominent<br>Brittle | 2.4<br>2.5 | Compact and lamellar | Associated with nepheline, sodalite, biotite and feldspar in nepheline rocks |
| Amorph. | C, none<br>F, conchoidal and prominent | 2.2 | Massive; wood-like | Softer than brown jasper; wood opal shows wood structure |
| Orth. | C, prismatic and brachypinacoidal, very prominent<br>Brittle | 3.2 | Bladed, columnar; massive | Often softer because of alteration to serpentine; pearly cleavage faces usual |
| Orth. | C, prismatic and brachypinacoidal, very prominent<br>Brittle | 3.5 | Reticulated masses; columnar | Bronze luster and color characteristic |
| Orth. | C, clinopinacoidal, very prominent<br>Brittle | 3.5 | Broad cleavage; masses | More bronze brown than hornblende |
| Mono. | C, prismatic, not usually prominent<br>Cleavage angle 87° | 3.5 | Crystals | Distinguished from hornblende by the prism being nearly square |
| Orth. | C, prismatic and prominent | 3.2 | Lamellar; fibrous; reticulated; columnar | Often soft because of alteration; structure resembles actinolite |
| Mono. | C, prismatic and prominent | 2.9<br>3.4 | Bladed; columnar; prismatic; fibrous | Cleavage angle 124°: often in marble or calcite with brown tourmaline |
| Mono. | C, prismatic, very prominent | 3.4 | Crystals | Prismatic cleavage angle about 124° |

COLOR YELLOW OR BROWN.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| NEPHELITE (Elæolite) | $NaAlSiO_4$ | Reddish brown | Greasy Vitreous | 5.5 6 |
| ALLANITE | $(CaFe_2)(Al,Fe,Ce)_2(AlOH)$-$(SiO_4)_3$ | Dark brown Blackish brown | Pitchy Submetallic | 5.5 6 |
| SILLIMANITE (Fibrolite) | $Al_2SiO_5$ | Light grayish brown Hair-brown | Vitreous | 6 7 |
| ZOISITE | $Ca_2Al_2(AlOH)(SiO_4)_3$ | Grayish brown Yellowish brown | Vitreous | 6 6.5 |
| **EPIDOTE** | $HCa_2(Al,Fe)_3Si_3O_{13}$ | Oil brown Greenish brown Greenish yellow | Vitreous | 6 7 |
| **RUTILE** | $TiO_2$ | Reddish brown | Adamantine | 6 6.5 |
| **CASSITERITE** | $SnO_2$ | Reddish brown Yellowish brown | Adamantine Dull | 6 7 |
| CHONDRODITE | $Mg_3[Mg(F,OH)_2(SiO_4)_2]$ | Reddish brown Brownish yellow | Vitreous | 6 6.5 |
| AXINITE | $HCa_3Al_2B(SiO_4)_4$ | Clove-brown Yellow | Vitreous | 6.5 7 |
| **ORTHOCLASE** | $KAlSi_3O_8$ | Pale brown Flesh-brown | Vitreous Pearly | 6 6.5 |
| **QUARTZ** var. Citron Smoky Ferruginous | $SiO_2$ | Brownish yellow Hair-brown Smoky brown Yellowish brown Reddish brown | Vitreous Glassy Greasy | 7 |
| **CHALCEDONY** var. Agate Jasper Flint | $SiO_2$ | Brown or yellow in all shades | Waxy Vitreous | 7 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Hex. | C, prismatic, not prominent<br>Brittle | 2.6 | Massive | Usually in crystalline rock with feldspar, biotite, leucite |
| Mono. | C, not important<br>F, uneven<br>Brittle | 3.5<br>4.2 | Thin tabular crystals; seldom massive | In granitic rocks as thin brownish, pitch-like crystals and streaks |
| Orth. | C, brachypinacoidal, prominent<br>Brittle | 3.2 | Long slender prisms; fibers; columns | Always in schist rocks; fibers often bent and reticulated |
| Orth. | C, brachypinacoidal, prominent<br>Brittle | 3.2 | Stout columns; sometimes fibrous masses | Columnar crystals usually much broken by cross-fracture |
| Mono. | C, basal, perfect, sometimes prominent<br>Brittle | 3.2<br>3.5 | Prismatic crystals; columnar; fine granular | Often as prisms in quartz |
| Tetrag. | C, prismatic, not important<br>Brittle | 4.2 | Twinned crystals; long prisms; acicular | Crystals usually with deeply striated faces; knee-shaped twins |
| Tetrag. | C, not important<br>F, uneven<br>Brittle | 6.8<br>7 | Crystals; rounded pebbles | Pebbles of reddish, grayish, and yellowish color, with often concentric structure |
| Mono. | C, not prominent<br>F, uneven, brittle | 3.2 | Crystals; embedded grains in rock | Often in calcite with octahedrons of spinel |
| Tric. | C, not prominent<br>F, conchoidal<br>Brittle | 3.2 | Thin sharp-edged crystals | Often with garnet, tourmaline, albite, quartz |
| Mono. | C, basal and clinopinacoidal, very prominent | 2.6 | Crystals; cleavage pieces; massive | Commonly with quartz, mica, hornblende; two cleavages at R. A. |
| Hex. | C, none<br>F, conchoidal<br>Very prominent<br>Brittle | 2.6 | Hexagonal prisms and pyramids; prism faces usually horizontally striated; massive. | Smoky quartz common in granites with orthoclase, biotite, or hornblende; conchoidal fracture characteristic |
| Hex. | C, none<br>F, conchoidal<br>Very prominent<br>Brittle | 2.6 | Colloidal masses; often banded; botryoidal; mammillary | Conchoidal fracture, very characteristic |

| | Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|---|
| COLOR YELLOW OR BROWN. | VESUVIANITE | $Ca_6(AlOH)Al_2(SiO_4)_5$ | Dark brown<br>Greenish brown<br>Brownish yellow<br>Greenish yellow | Vitreous<br>Greasy | 6.5<br>7 |
| | GARNET<br>var. Grossularite<br>Andradite<br>Almandite<br>Spessartite<br>Pyrope | <br>$Ca_3Al_2(SiO_4)_3$<br>$Ca_3Fe_2(SiO_4)_3$<br>$Fe_3Al_2(SiO_4)_3$<br>$Mn_3Al_2(SiO_4)_3$<br>$Mg_3Al_2(SiO_4)_3$ | <br>Reddish brown<br>Yellowish brown<br>Reddish yellow<br>Brownish yellow | Vitreous | 6.5<br>7.5 |
| | TOURMALINE | $7H_2O.2Na_2O.12MgO.6B_2O_3.$-<br>$13Al_2O_3 24SiO_2$ | Cinnamon-brown<br>Dark brown | Vitreous<br>Glassy | 7<br>7.5 |
| | STAUROLITE | $(AlO)_4(AlOH)Fe(SiO_4)_2$ | Dark reddish brown | Vitreous | 7<br>7.5 |
| | BERYL | $Be_3Al_2(SiO_3)_6$ | Golden yellow<br>Greenish yellow | Vitreous<br>Glassy | 7.5<br>8 |
| | ZIRCON | $ZrSiO_4$ | Slate-brown<br>Light brown<br>Dark brown | Vitreous<br>Pearly<br>Resinous | 7.5<br>8 |
| | TOPAZ | $Al_2(F,OH)_2SiO_4$ | Honey-yellow<br>Wine-yellow<br>Yellowish brown | Vitreous | 8 |
| | CORUNDUM | $Al_2O_3$ | Light brown<br>Grayish brown | Vitreous | 9 |
| PINK, RED, OR RED-VIOLET. | GYPSUM | $CaSO_4 \cdot 2H_2O$ | Brick-red | Vitreous<br>Silky | 1.5<br>2 |
| | LEPIDOLITE | $(Li,K)_2Al_2(F,OH)_2(SiO_3)_3$ | Pale pink to<br>Deep rose-red | Pearly | 2.5<br>4 |
| | VANADINITE | $(PbCl)Pb_4(VO_4)_3$ | Bright red<br>Orange-red<br>Ruby-red | Adamantine<br>Greasy | 2.5<br>3 |
| | WULFENITE | $PbMoO_4$ | Orange-red | Adamantine<br>Greasy | 3 |
| | CALCITE | $CaCO_3$ | Pink<br>Brick-red | Vitreous | 3 |

| System. | Cleavage or Fracture. | G | Common Structure. | Observations. |
|---|---|---|---|---|
| Tetrag. | C, not prominent<br>Brittle | 3.4 | Square prisms with low pyramids; massive; granular | Often in white or blue calcite; prism faces generally vertically striated |
| Isom. | C, none<br>F, uneven, coarse<br>Brittle | 3.1<br>4.3 | Crystals; dodecahedrons with icosatetrahedrons; granular; massive | Often in schists and gneisses; also with calcite; usually in crystals |
| Hex. | C, none<br>F, uneven<br>Very brittle | 3<br>3.2 | Trigonal; prisms with vertically striated faces | Prisms usually much cross-fractured; often in calcite with tremolite |
| Orth. | C, not important<br>F, uneven<br>Brittle | 3.7 | Crystals; often twinned in crosses, or ×-shaped | Usually in schists; often with cyanite; sillimanite |
| Hex. | C, not important<br>F, uneven<br>Brittle | 2.6<br>2.8 | Hexagonal prisms with base | Harder than quartz, and crystals have basal planes |
| Tetrag. | C, none<br>F, conchoidal<br>Brittle | 4.7 | Square prisms with pyramids; rounded grains | Often in granitic rocks; crystals always, and usually small |
| Orth. | C, basal, very prominent<br>Brittle | 3.4<br>3.6 | Crystals; prisms; pyramids | Always in crystals; sometimes in cavities in rhyolite |
| Hex. | C, rhombohedral, often prominent<br>Brittle or<br>Tough | 3.9<br>4.1 | Massive; crystals | Hard brownish masses often in red orthoclase feldspar |
| Mono. | C, clinopinatoidal, perfect and prominent<br>Brittle | 2.3 | Columnar; fibrous; massive; granular | Gypsum stained by ferric oxide |
| Mono. | C, basal, perfect and prominent<br>Tough | 2.9 | Micaceous; flakes; scales; compact scaly masses | Usually with rose-red tourmaline, feldspar, or quartz |
| Hex. | C, not important<br>Brittle | 6.6<br>7.2 | Small hexagonal prisms | Often with wulfenite or galenite |
| Tetrag. | C, not important<br>Brittle | 6.7<br>7 | Square tabular crystals | Often with vanadinite |
| Hex. | C, rhombohedral, prominent<br>Brittle | 2.7 | Rhombohedrons; stalactites; massive | Color due to stain of ferric oxide or manganese oxide |

COLOR PINK, RED, OR RED-VIOLET.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| CELESTITE | $SrSO_4$ | Brick-red | Vitreous | 3<br>3.5 |
| HEULANDITE | $H_4CaAl_2(SiO_3)_6 \cdot 3H_2O$ | Deep brick-red<br>Flesh red | Pearly | 3<br>5.4 |
| **SPHALERITE** | $ZnS$ | Brownish red<br>Yellowish red | Resinous | 3.5<br>4 |
| **DOLOMITE** | $(Ca,Mg)CO_3$ | Pale pink | Vitreous | 3.5<br>4 |
| **RHODOCHROSITE** | $MnCO_3$ | Rose-red | Vitreous | 3.5<br>4.5 |
| MARGARITE | $H_2CaAl_4Si_2O_{12}$ | Pink<br>Rose-red | Pearly<br>Vitreous | 3.5<br>4.5 |
| **FLUORITE** | $CaF_2$ | Violet-red<br>Purple<br>Pink<br>Amethystine | Vitreous<br>Glassy | 4 |
| CHABAZITE | $CaAl_2(SiO_3)_4 \cdot 6H_2O$ | Pale brick-red<br>Flesh-red | Vitreous | 4<br>5 |
| APOPHYLLITE | $(H,K)_2Ca(SiO_3)_2 \cdot H_2O$ | Pale violet-red | Vitreous<br>Pearly | 4.5<br>5 |
| APATITE | $(CaF)Ca_4(PO_4)_3$<br>$(CaCl)Ca_4(PO_4)_3$ | Pink<br>Brownish red | Vitreous<br>Greasy | 5 |
| **SCAPOLITE**<br>WERNERITE | $Ca_4Al_6Si_6O_{25}$<br>with<br>$Na_4Al_3ClSi_9O_{24}$ | Lilac-red<br>Violet-red<br>Pink | Vitreous<br>Greasy | 5.5 |
| **RHODONITE** | $MnSiO_3$ | Rose-red<br>Brownish red | Vitreous | 5.5<br>6.5 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Orth. | C, basal very prominent; prismatic less prominent | 3.9 | Platy masses | Uncommon color; in cavities in dark gray limestone |
| Mono. | C, clinopinacoidal, prominent<br>Brittle | 2.2 | Tabular plates; crystals | Often in cavities of lava rock with stilbite, chabazite, analcite |
| Isom. | C, dodecahedral, very prominent<br>Brittle | 3.9<br>4.1 | Crystals; massive | Cleavage masses common; occurs with various sulphides |
| Hex. | C, rhombohedral, not usually prominent<br>Brittle | 2.9 | Rhombohedrons; with curved faces; saddle-shaped crystals | Often with galenite, calcite quartz, chalcopyrite |
| Hex. | C, rhombohedral, very prominent<br>Brittle | 3.4<br>3.6 | Rhombohedrons; massive | Often with silver ores, also quartz, galenite, pyrite |
| Mono. | C, basal, perfect and prominent<br>Brittle | 3 | Micaceous; foliated | Often as veins in green chlorite with diaspore, corundum; not elastic like muscovite; called brittle mica |
| Isom. | C, octahedral, perfect and prominent<br>Brittle | 3<br>3.2 | Cubes; massive | Often with cassiterite, wolframite, galenite, pyrite |
| Hex. | C, not prominent<br>F, uneven<br>Brittle | 2 | Crystals; rhombohedrons | Crystals almost cubes in shape; often with stilbite and heulandite in cavities in lava |
| Tetrag. | C, basal, perfect and prominent<br>Brittle | 2.4 | Square prisms with base; resemble cubes | Prism faces vertically striated; basal planes have very pearly luster |
| Hex. | C, basal but not prominent<br>Brittle | 3.2 | Hexagonal prisms; granular | Uncommon color; usually green and brown; often with calcite |
| Tetrag. | C, not prominent<br>Brittle | 2.6<br>2.8 | Massive; coarse granular | Harder than fluorite |
| Tric. | C, prismatic, prominent<br>Tough | 3.4<br>3.6 | Massive granular; crystals | Often in calcite with franklinite; also with silver ores |

COLOR PINK, RED, OR RED-VIOLET.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| **OPAL** | $SiO_2 \cdot nH_2O$ | Brownish red | Waxy | 5.5<br>6.5 |
| **ORTHOCLASE** | $KAlSi_3O_8$ | Brick-red<br>Flesh-red | Vitreous<br>Pearly | 6<br>6.5 |
| CHONDRODITE | $Mg_3[Mg(F,OH)_2](SiO_4)_2$ | Dark red<br>Brownish red | Vitreous | 6<br>6.5 |
| **RUTILE** | $TiO_2$ | Dark red | Adamantine | 6<br>6.5 |
| **QUARTZ**<br>var. Amethyst<br>Rose<br>Ferruginous | $SiO_2$ | Amethystine<br>Rose-red<br>Brick-red<br>Violet-red | Vitreous<br>Glassy<br>Greasy | 7 |
| **CHALCEDONY**<br>var. Agate<br>Carnelian<br>Jasper | $SiO_2$ | Bright red<br>Carnelian-red<br>Dark red,<br>Brownish red | Waxy<br>Vitreous | 7 |
| **GARNET**<br>var. Grossularite<br>Essonite<br>Andradite<br>Pyrope<br>Almandite<br>Spessartite | <br>$Ca_3Al_2(SiO_4)_3$<br>$Ca_3Fe_2(SiO_4)_3$<br>$Mg_3(Fe,Al)_2(SiO_4)_3$<br>$(Mg,Fe)_3(Fe,Al)_2(SiO_4)_3$<br>$Mn_3(Fe,Al)_2(SiO_4)_3$ | Light to dark red<br>Brownish red<br>Cinnamon-red<br>Rose-red | Vitreous | 6.5<br>7.5 |
| **TOURMALINE** | $H_8(Na,Li)_4Al_{10}B_6Si_{12}O_{63}$ | Pink<br>Rose-red | Vitreous<br>Glassy | 7<br>7.5 |
| ANDALUSITE | $Al_2SiO_5$ | Pink<br>Pale rose | Vitreous | 7<br>7.5 |
| **STAUROLITE** | $(AlO)_4(AlOH)Fe(SiO_4)_2$ | Dark brownish red | Vitreous | 7<br>7.5 |
| **SPINEL** | $MgAl_2O_4$ | Ruby-red | Vitreous | 8 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Amorph. | C, none<br>F, conchoidal, prominent | 1.9<br>1.9 | Colloidal masses | Conchoidal fracture characteristic; softer than jasper |
| Mono. | C, basal and clinopinacoidal, prominent | 2.6 | Crystals; massive | Occurs with quartz, mica, hornblende in red granite; see feldspar. |
| Mono. | C, not prominent<br>F, uneven<br>Brittle | 3.2 | Crystals; embedded grains | Occurs with spinel in crystalline limestone; often with chlorite |
| Tetrag. | C, not prominent<br>F, uneven<br>Brittle | 4.2 | Crystals; long slender prisms; acicular | Often as acicular crystals in quartz |
| Hex. | C, none<br>F, conchoidal, prominent<br>Brittle | 2.6 | Hexagonal prisms and pyramids; massive | Ferruginous quartz usually with specular hematite; rose quartz usually massive; amethyst usually in crystals |
| Hex. | C, none<br>F, conchoidal, prominent<br>Brittle to tough | 2.6 | Massive; cryptocrystalline; banded | Very common as jasper; agate usually finely banded |
| Isom. | C, not prominent<br>F, uneven<br>Brittle | 3.1<br>4.3 | Crystals; granular; rounded grains; massive | Common in schists, gneisses, and crystalline limestone<br>Some massive dark red shows good cleavage |
| Hex. | C, none<br>F, uneven<br>Very brittle | 3<br>3.2 | Prismatic, often radiate or divergent; long trigonal prisms | Usually in lepidolite; crystals often parti-colored red and green |
| Orth. | C, not prominent<br>Brittle | 3.2 | Crystals; nearly square prisms; massive | Often in schists with albite, staurolite |
| Orth. | C, imperfect<br>Brittle | 3.7 | Crystals; often twinned into crosses and × shapes | Occurs in schists with cyanite, sillimanite, andalusite, chlorite |
| Isom | C, imperfect<br>Brittle | 3.5<br>4.1 | Rounded grains; small octahedrons | Resembles red garnet and ruby corundum |

COLOR BLUE OR BLUE-VIOLET.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| Topaz | $Al_2(F,OH)_2SiO_4$ | Pink | Vitreous | 8 |
| Corundum | $Al_2O_3$ | Ruby-red | Vitreous | 9 |
| Vivianite | $Fe_3P_2O_8 \cdot 8H_2O$ | Greenish blue<br>Indigo-blue | Vitreous<br>Pearly<br>Dull | 1.5<br>2 |
| Chalcanthite | $CuSO_4 \cdot 5H_2O$ | Sky-blue<br>Greenish blue | Vitreous | 2.5 |
| **CHRYSOCOLLA** | $CuSiO_3 \cdot 2H_2O$ | Greenish blue | Greasy<br>Vitreous<br>Dull | 2<br>4 |
| Lepidolite (Mica) | $(LiK)_2Al_2(F,OH)_2(SiO_3)_3$ | Lavender-blue | Pearly<br>Vitreous | 2.5<br>4 |
| **CALCITE** | $CaCO_3$ | Sky-blue | Vitreous | 3 |
| **CELESTITE** | $SrSO_4$ | Light sky-blue | Vitreous | 3<br>3.5 |
| Barite | $BaSO_4$ | Pale greenish blue | Vitreous | 2.5<br>3.5 |
| **FLUORITE** | $CaF_2$ | Violet-blue<br>Greenish blue | Vitreous<br>Very glassy | 4 |
| Calamine | $H_2Zn_2SiO_5$ | Pale blue | Vitreous<br>Silky | 4.5<br>5 |
| Sodalite | $Na_4(Al,Cl)Al_2Si_3O_{12}$ | Lavender-blue<br>Azure-blue | Vitreous<br>Greasy | 5.5<br>6 |
| Lazurite (Lapis Lazuli) | $Na_4(AlS_2Na)Al_2(SiO_4)_3$ | Deep azure-blue<br>Berlin blue<br>Ultramarine blue | Vitreous | 5<br>5.5 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Orth. | C, basal, very perfect and prominent<br>Brittle | 3.4<br>3.6 | Crystals | Usually artificially colored; uncommon color in nature |
| Hex. | C, rhombohedral, not prominent<br>Brittle to tough | 3.9<br>4.3 | Crystals; grains; massive | Often intermixed with blue when massive; very hard |
| Mono. | C, pinacoidal, prominent in crystals | 2.6 | Long prisms; fibrous; earthy | Earthy globular masses in clay or rock, common; prisms in pyrrhotite cavities |
| Tric. | C, not prominent<br>F, conchoidal<br>Brittle | 2.1<br>2.3 | Crystals; massive; stalactitic; fibrous | Taste metallic, nauseous; artificial crystals common; as blue vitriol |
| Amorph. | C, none<br>F, conchoidal<br>Sectile | 4<br>2.2 | Granular; stains; incrustations; seams | Often with clay, chalcopyrite, limonite, malachite |
| Mono. | C, basal, perfect and prominent<br>Tough | 2.9 | Compact masses of micaceous plates and scales | Associated with pink and green tourmaline, albite and quartz |
| Hex. | C, rhombohedral, very prominent<br>Brittle | 2.7 | Coarsely granular; coarse cleavage masses | Often with vesuvianite, pyroxene |
| Orth. | C, basal and prismatic, prominent | 3.9 | Massive; fibrous | Massive varieties show good cleavage and are almost colorless; heavy |
| Orth. | C, not prominent<br>F, fibrous | 4.3<br>4.6 | Fibrous | Heavy fibrous mineral |
| Isom. | C, octahedral very prominent<br>Brittle | 3<br>3.2 | Cubes; compact or granular; massive | Usually violet-blue or greenish blue; often with galena, cassiterite |
| Orth. | C, prismatic, sometimes prominent | 3.5 | Drusy crystals; coatings; massive | Geodal-shaped masses with drusy surface; also layers of radiating fibers |
| Isom. | C, dodecahedral, not prominent<br>Brittle | 2.1<br>2.5 | Massive; grains | Usually with nephelite, leucite and albite in syenite rock |
| Isom. | C, not prominent<br>Brittle | 2.4 | Massive | Usually intermixed with calcite and pyrite |

| | Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|---|
| COLOR BLUE OR BLUE-VIOLET. | LAZULITE | $MgAl_2P_2O_9 \cdot H_2O$ | Smalt-blue<br>Sky-blue<br>Azure-blue | Vitreous | 5.5<br>6 |
| | OPAL | $SiO_2 \cdot nH_2O$ | Pale grayish blue<br>Greenish blue | Waxy<br>Vitreous | 5.5<br>6.5 |
| | **CYANITE** | $Al_2SiO_5$ | Sky-blue<br>Pale greenish blue | Vitreous<br>Pearly | 5<br>7 |
| | TURQUOIS | $AlPO_4Al(OH)_3 \cdot H_2O$ | Greenish blue | Dull<br>Waxy | 6 |
| | QUARTZ | $SiO_2$ | Grayish blue<br>Greenish blue | Vitreous<br>Glassy | 7 |
| | **CHALCEDONY** | $SiO_2$ | Grayish blue<br>Greenish blue | Waxy<br>Greasy | 7 |
| | CORDIERITE<br>(Iolite) | $Al_6Mg_4(AlOH)_2(Si_2O_7)_5$ | Grayish blue<br>Greenish blue<br>Smoky blue | Vitreous<br>Glassy | 7<br>7.5 |
| | **BERYL** | $Be_3Al_2(SiO_4)_6$ | Aquamarine blue<br>Pale blue<br>Sky-blue | Vitreous<br>Glassy | 7.5<br>8 |
| | TOPAZ | $Al_2(F,OH)_2SiO_4$ | Greenish blue<br>Sky-blue | Vitreous | 8 |
| | **CORUNDUM** | $Al_2O_3$ | Grayish blue<br>Sapphire-blue | Vitreous | 9 |
| COLOR GREEN. | **TALC** | $H_2Mg_3(SiO_3)_4$ | Pale green<br>Deep green | Greasy | 1<br>1.5 |
| | VIVIANITE | $Fe_3P_2O_8 \cdot 8H_2O$ | Bluish green | Vitreous<br>Pearly<br>Dull | 1.5<br>2 |
| | MELANTERITE | $FeSO_4 \cdot 7H_2O$ | Pale green<br>to white | Vitreous<br>Earthy | 2 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Mono. | C, not prominent<br>F, uneven<br>Brittle | 3 | Crystals; acute pointed pyramids | Usually as crystals in white quartzite rock |
| Amorph. | C, none<br>F, conchoidal, prominent | 1.9<br>2.3 | Massive | Color not usually homogeneous |
| Tric. | C, pinacoidal, prominent<br>Tough | 3.6 | Bladed; reticulated | Cleavage faces usually wavy or bent and with much cross parting; often in schists with staurolite |
| None | C, none<br>F, uneven | 2.6 | Irregular-shaped masses; grains; seams; impalpable | Occurs intermixed with rock in veins, seams, etc. |
| Hex. | C, none<br>F, conchoidal and prominent | 2.6 | Crystals; massive | Much more glassy and crystalline than chalcedony |
| Hex. | C, none<br>F, conchoidal, prominent | 2.6 | Geodes; botryoidal; banded; stalactitic | Geodes often have glassy quartz centers |
| Orth. | C, not important<br>F, uneven<br>Brittle | 2.6 | Massive; granular | Occurs in gneisses and schists with sillimanite, andalusite; resembles blue quartz |
| Hex. | C, rough basal<br>F, uneven<br>Brittle | 2.6<br>2.8 | Hexagonal prisms; broken crystals | Occurs in granite with quartz, feldspar, and mica |
| Orth. | C, basal, perfect and prominent<br>Brittle | 3.4<br>3.6 | Crystals | Resembles aquamarine beryl except in crystal form; not common color |
| Hex. | C, rhombohedral, prominent<br>Tough | 3.9<br>4.1 | Massive; grains; barrel-shaped crystals | Masses often show fine parallel striations due to twinning and cleavage |
| Orth. | C, basal, perfect and prominent<br>F, splintery, uneven | 2.8 | Foliated massive | Soft and greasy feel; very flexible, but not elastic |
| Mono. | C, clinopinacoidal, prominent in crystals<br>Brittle | 2.6 | Long prisms with striated faces; earthy; powder | Earthy masses in clay, bones, fossils; crystals often in pyrrhotite |
| Mono. | C, basal but not prominent<br>F, small conchoidal or earthy | 1.8<br>1.9 | Stalactitic; fine fibrous powder | Green when fresh but soon becomes white and powdery; alteration of iron sulphides; tastes like ink |

COLOR GREEN.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| GARNIERITE | $H_3(Ni,Mg)SiO_4 \cdot nH_2O$ | Apple-green | Dull | 1<br>2 |
| **CHLORITE**<br>PROCHLORITE<br>CLINOCHLORE | $H_8(Mg,Fe)_5Al_2Si_3O_{18}$ | Grass-green<br>Brownish green<br>Dark green | Pearly<br>Vitreous | 1.5<br>2.5 |
| MUSCOVITE<br>(Chrome mica)<br>MARIPOSITE | $H_2KAl_3(SiO_4)_3$ with Cr | Emerald-green<br>Apple-green | Pearly<br>Vitreous | 2<br>2.5 |
| **BIOTITE** | $(HK)_2(Mg,Fe)_2(AlFe)_2(SiO_4)_3$ | Brownish green<br>Deep green | Pearly<br>Vitreous | 2.5<br>3 |
| CHALCANTHITE | $CuSO_4 \cdot 5H_2O$ | Bluish green | Vitreous<br>Greasy | 2.5 |
| **CHRYSOCOLLA** | $CuSiO_3 \cdot 2H_2O$ | Bluish green | Greasy<br>Vitreous<br>Dull | 2<br>4 |
| **SERPENTINE**<br>CHRYSOTILE<br>ASBESTOS | $H_4Mg_3Si_2O_9$ | Oil-green<br>Light green<br>Dark green<br>Blackish green | Greasy<br>Silky | 2.5<br>4 |
| **ACTINOLITE** | $Ca(Mg,Fe)_3(SiO_3)_4$ | Grass-green<br>Deep green | Vitreous<br>Silky | 2.5<br>4 |
| **BARITE** | $BaSO_4$ | Pale green | Vitreous<br>Glassy | 2.5<br>3.5 |
| WAVELLITE | $Al_3(OH)_3(PO_4)_2 \cdot 5HO_2$ | Pale green<br>Bright green | Vitreous<br>Pearly | 3<br>4 |
| **PYROMORPHITE** | $(PbCl)Pb_4(PO_4)_3$ | Yellowish green<br>Dark green | Adaman-<br>tine<br>Pearly | 3.5<br>4 |
| **FLUORITE** | $CaF_2$ | Pale green<br>Bright green<br>Bluish green | Vitreous<br>Glassy | 4 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Amorph. | C, none<br>F, earthy | 2.3<br>2.8 | Friable masses; clay-like masses | Rounded and pod-shaped masses in clay |
| Mono. | C, basal, perfect and prominent<br>Tough | 2.8 | Foliated; micaceous; scaly; flaky | Flexible but not elastic; dark-colored in thin plates; very common in schists |
| Mono. | C, basal, perfect and prominent<br>Tough | 2.7<br>3 | Micaceous; scales; flakes; sheets | Light color to colorless in thin sheets; highly elastic. Forms schists |
| Mono. | C, basal, perfect and prominent<br>Tough | 2.7<br>3.1 | Micaceous; scales; flakes | Dark-colored mica in thinnest sheets; elastic and flexible |
| Tric. | C, not prominent<br>F, conchoidal<br>Brittle | 2.1<br>2.3 | Crystals; massive; cross-fibered veins | Taste nauseous metallic; blue vitriol |
| Amorph. | C, none<br>F, conchoidal<br>Sectile to brittle | 2<br>2.2 | Incrustations; seams; stains | Never fibrous like malachite; often with malachite, chalcopyrite |
| Mono. | C, not important<br>F, conchoidal or splintery | 2.6 | Massive; fibrous | Feels smooth and looks greasy; dark masses often intersected by veinlets of chrysotile asbestos |
| Mono. | C, fibrous<br>Brittle | 3 | Fibrous reticulated masses | Occurs as actinolite schists; individual prisms are harder |
| Orth. | C, basal and prismatic, very prominent<br>Brittle | 4.3<br>4.6 | Platy; massive; crystals | Usually nearly colorless with greenish cast; heavy vitreous mineral |
| Orth. | C, not prominent<br>Brittle | 2.3 | Fine radiating fibrous globules; rosette-like | Usually on rock surface as small fibrous rosettes |
| Hex. | C, not prominent<br>Brittle | 6.5<br>7.1 | Hexagonal prisms with striated faces; granular; fibrous | Often with galena, anglesite, mimetite |
| Isom. | C, octahedral, very prominent<br>Brittle | 3<br>3.2 | Cubes; octahedral cleavage pieces; massive; granular | Often with calcite, galena, pyrite, dolomite |

COLOR GREEN.

| | Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|---|
| | CALAMINE | $H_2Zn_2SiO_5$ | Bluish green<br>Pale green | Vitreous | 4.5<br>5 |
| | SMITHSONITE | $ZnCO_3$ | Grayish green<br>Bluish green | Vitreous | 5 |
| | APATITE | $(CaF)Ca_4(PO_4)_3$ or<br>$(CaCl)Ca_4(PO_4)_3$ | Pale green<br>Grass-green<br>Dark green<br>Brownish green | Greasy<br>Vitreous | 5 |
| | OPAL | $SiO_2 \cdot nH_2O$ | Grayish green | Waxy<br>Vitreous | 5.5<br>6.5 |
| | WILLEMITE | $Zn_2SiO_4$ | Yellowish green<br>Bright green | Vitreous | 5.5 |
| | CYANITE | $Al_2SiO_5$ | Pale bluish green | Vitreous | 4<br>7 |
| PYROXENE | ENSTATITE | $MgSiO_3$ | Grayish green<br>Brownish green | Vitreous<br>Pearly<br>Silky | 5.5 |
| PYROXENE | DIOPSIDE | $CaMg(SiO_3)_2$ | Pale green<br>Bright green | Vitreous<br>Glassy | 5<br>6.6 |
| PYROXENE | AUGITE | Silicate of Ca, Mg, Fe and Al, chiefly | Blackish green | Vitreous | 5<br>6 |
| AMPHIBOLE | ACTINOLITE | $Ca(Mg,Fe)_3(SiO_3)_4$ | Grass-green<br>Dark green | Vitreous<br>Silky | 5<br>6 |
| AMPHIBOLE | HORNBLENDE | Silicate of Ca, Mg, Fe, and Al, chiefly | Blackish green | Vitreous<br>Pearly | 5<br>6 |
| | TURQUOIS (Variscite) | $AlPO_4Al(OH)_3 \cdot H_2O$ | Bluish green<br>Apple-green | Waxy<br>Dull | 5<br>6 |

| System . | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Orth. | C, prismatic, sometimes prominent | 3.5 | Fibrous mammillary masses | Often with smithsonite |
| Hex. | C, rhombodehral, not usually prominent<br>Brittle | 4.4 | Drusy masses; botroyidal or mammillary shapes | Usually very compact, like chalcedony |
| Hex. | C, basal, not prominent<br>Brittle | 3.2 | Hexagonal prisms; granular; massive | Commonly intermixed with brown colors; often with calcite; crystals often have fused appearance |
| Amorph. | C, none<br>F, conchoidal and prominent | 1.9<br>2.3 | Colloidal masses | Waxy luster characteristic |
| Hex. | C, prismatic, not prominent | 3.9<br>4.1 | Massive; granular | Usually with franklinite, zincite, and calcite |
| Tric. | C, macropinacoidal, prominent<br>Tough | 3.6 | Bladed; columnar | Divergent columnar; long blades usually bent and cross-fractured; easily scratched lengthwise but very hard crosswise |
| Orth. | C, prismatic, prominent<br>Brittle | 3.1<br>3.3 | Prismatic masses; divergent columns | Often much softer, owing to alteration to serpentine |
| Mono. | C, prismatic, not prominent<br>Brittle | 3.3 | Crystals; square prisms with oblique base | Usually prisms have a prominent basal parting. Green grains in crystalline limestone |
| Mono. | C, prismatic, not prominent<br>Cleavage angle=87° | 3.3 | Crystals; massive | Cleavage not so prominent as in hornblende; more common as crystals |
| Mono. | C, prismatic, prominent<br>Cleavage angle = 124° | 3<br>3.2 | Divergent columnar or fibrous; reticulated masses | Often with talc or chlorite; fine to coarse fibrous and reticulated; often in schists |
| Mono. | C, prismatic and very prominent<br>Cleavage angle = 124° | 3<br>3.2 | Massive; prismatic; columnar | Cleavage faces usually have fibrous appearance; common in granitic rocks and schists |
| None | C, none<br>Brittle | 2.6 | Globular masses; veins; seams | Usually intermixed with rock in irregular masses or veinlets |

COLOR GREEN.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| NEPHELITE (Elæolite) | $(Na,K)AlSiO_4$ | Grayish green<br>Brownish green | Greasy<br>Vitreous | 5.5<br>6 |
| **MICROCLINE** (Feldspar) | $KAl \cdot SI_3O_8$ | Bright green | Vitreous<br>Pearly | 6<br>6.5 |
| PREHNITE | $H_2Ca_2Al_2(SiO_4)_3$ | Pale green<br>Bright green | Vitreous | 6<br>6.5 |
| CHLORITOID | $H_2(Fe,Mg)Al_2SiO_7$ | Dark green<br>Greenish black | Pearly<br>Vitreous | 6.5 |
| **EPIDOTE** | $HCa_2(Al,Fe)_3Si_3O_{13}$ | Pistachio-green<br>Yellowish green<br>Oil-green<br>Brownish green | Vitreous | 6<br>7 |
| **VESUVIANITE** | $Ca_6(AlOH)Al_2(SiO_4)_5$ | Brownish green<br>Bright green | Vitreous<br>Greasy | 6.5 |
| **OLIVINE** (Chrysolite) | $(Mg,Fe)_2SiO_4$ | Bottle-green<br>Oil-green<br>Grass-green | Vitreous<br>Glassy | 6.5<br>7 |
| NEPHRITE<br>JADE | $NaAl(SiO_3)_2$ | Grayish green<br>Deep green | Vitreous<br>Silky | 6.5<br>7 |
| **QUARTZ** | $SiO_2$ | Light to dark green | Vitreous<br>Glassy | 7 |
| **CHALCEDONY**<br>var. Jasper<br>Chrysoprase<br>Plasma | $SiO_2$ | Apple-green<br>Leek-green<br>Light to dark green | Vitreous<br>Waxy | 7 |
| GARNET (Uvarovite) | $Ca_3Cr_2(SiO_4)_3$ | Emerald-green | Vitreous | 7<br>7.5 |
| **TOURMALINE** | $4H_2O \cdot 2(Na,Li)_2O \cdot 3B_2O_3 \cdot 8Al_2O_3 \cdot 12SiO_2$ | Dark green | Vitreous<br>Glassy | 7<br>7.5 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Hex. | C, not prominent<br>Brittle | 2.6 | Massive; short hexagonal prisms (rare) | Usually with augite sodalite, leucite, cancrinite nepheline rocks usually have greasy appearance |
| Tric. | C, basal and brachypinacoidal<br>Brittle | 2.5 | Crystals; cleavage pieces | Pearly luster on basal cleavage, also vein-like markings; green Amazon stone |
| Orth. | C, not prominent<br>F, uneven<br>Brittle | 2.9 | Reniform masses with drusy surfaces; small stalactitic | Occurs usually in cavities and fissures in basalts and diabases |
| Mono. | C, basal, prominent<br>Brittle | 3.5 | Foliated massive; micaceous; platy | Deep green in thin plates; resembles hornblende |
| Mono. | C, basal, perfect and usually prominent<br>Brittle | 3.2<br>3.5 | Crystals; prismatic; long columnar; granular; massive | Often in quartz; also with pyroxene, hornblende, magnetite, garnet |
| Tetrag. | C, not prominent<br>F, uneven<br>Brittle | 3.4 | Square prisms; faces often vertically striated; massive; granular | Often with calcite; crystals usually not perfect |
| Orth. | C, not important<br>Brittle | 3.3 | Rounded masses of green grains; massive granular | Occurs in basalt as bomb-shaped masses of light and dark green, very glassy grains |
| Mono. | C, not prominent<br>Tough | 3.3 | Very compact fibrous | Tough masses of interlocking fibers. Jade is compact without fibrous structure |
| Hex. | C, none<br>F, conchoidal and prominent | 2.6 | Hexagonal prisms and pyramids | Quartz stained with chlorite or actinolite |
| Hex. | C, none<br>F, conchoidal and prominent<br>Brittle | 2.6 | Massive, compact; cryptocrystalline | Not so glassy as quartz; chrysoprase is light apple-green |
| Isom. | C, none<br>Brittle | 3.5 | Small crystals; granular | Sometimes on chromite as green glassy crystals |
| Hex. | C, none<br>F, uneven<br>Very brittle | 3<br>3.2 | Trigonal or hexagonal prisms | Often with pink tourmaline in lepidolite or with quartz, biotite, feldspar |

| | Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|---|
| COLOR GREEN. | **BERYL**<br>var. Aquamarine<br>Emerald<br>Common | $Be_3Al_2(SiO_3)_6$ | Pale green<br>Bluish green<br>Sea-green<br>Emerald-green | Vitreous<br>Very glassy | 7.5<br>8 |
| | TOPAZ | $Al_2(F,OH)_2SiO_4$ | Bluish green | Vitreous | 8 |
| | CHRYSOBERYL | $BeAl_2O_4$ | Brownish green | Greasy<br>Vitreous | 8<br>8.5 |
| | CORUNDUM | $Al_2O_3$ | Bluish green<br>Grayish green | Vitreous | 9 |
| COLOR BLACK. | **BIOTITE**<br>(Mica) | $(HK)_2(Mg,Fe)_2(Al,Fe)_2(SiO_4)_3$ | Brownish black<br>Greenish black | Vitreous<br>Pearly | 2.5<br>3 |
| | CALCITE<br>DOLOMITE<br>(Limestone) | $CaCO_3$<br>$(Ca,Mg)CO_3$ | Grayish black | Vitreous | 3<br>3.5<br>4 |
| | FLUORITE | $CaF_2$ | Dark purple-black | Vitreous | 4 |
| | **HORNBLENDE** | Silicate of Ca, Mg, Fe, and Al, chiefly | Greenish black<br>Brownish black | Vitreous<br>Silky<br>Pearly | 5<br>6 |
| | **AUGITE** | Silicate of Ca, Mg, Fe, and Al, chiefly | Greenish black<br>Brownish black | Vitreous | 5<br>6 |
| | ALLANITE | $(Ca,Fe)_2(Al,Ce,Fe)_2(AlOH)(SiO_4)_3$ | Brownish black<br>Pitch-black | Pitchlike<br>Submetallic | 5.5<br>6 |
| | BROOKITE | $TiO_2$ | Brownish black | Submetallic<br>Adamantine | 5.5<br>6 |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Hex. | C, rough basal, not prominent<br>Brittle | 2.6<br>2.8 | Hexagonal prisms with basal planes; broken crystals | Often in granite with mica and feldspar<br>Transparent |
| Orth. | C, basal, perfect and prominent<br>Brittle | 3.4<br>3.6 | Crystals | Often nearly square prisms with base; resembles aquamarine beryl, except in form. Transparent |
| Orth. | C, not prominent<br>Brittle | 3.5<br>3.8 | Twinned crystals; tabular | Plates with twinning striations radiating from center; occurs with feldspar, garnet |
| Hex. | C, rhombohedral prominent<br>Tough | 3.9<br>4.1 | Massive | Often with cleavage striations on faces; uncommon color |
| Mono. | C, basal, perfect and prominent<br>Tough | 2.7<br>3.1 | Micaceous; plates; scales | Dark-colored mica in thinnest plates; common in granitic rocks |
| Hex. | C, none<br>F, fine or coarse granular<br>Brittle | 2.7<br>2.9 | Compact granular | Black limestone or marble |
| Isom. | C, octahedral, prominent<br>Brittle | 3<br>3.2 | Massive; banded | Black color not common |
| Mono. | C, prismatic, prominent<br>Cleavage angle 124° | 2.9<br>3.4 | Massive; fibrous; long prismatic | Cleavage faces very bright with often fibrous appearance; common with feldspar, quartz. Very common rock-forming mineral |
| Mono. | C, prismatic, not very prominent<br>Cleavage angle 87° | 3.3 | Almost square prisms with oblique bases; massive | Usually with dark basaltic rocks; cleavage not so good as in hornblende |
| Mono. | C, not prominent<br>F, uneven<br>Brittle | 3.5<br>4.2 | Tabular crystals; thin seams in rock; massive | Occurs in granitic rocks as black, pitch-like veins or as crystals; massive in pegmatite veins |
| Orth. | C, not prominent<br>Brittle | 3.8<br>4.8 | Crystals only square or hexagonal-shaped pyramids | Crystal faces often striated; not twinned like rutile |

| | Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|---|
| COLOR BLACK. | **RUTILE** | $TiO_2$ | Brownish black | Metallic<br>Adamantine | **6**<br>**6.5** |
| | **CASSITERITE** | $SnO_2$ | Black | Submetallic<br>Adamantine | **6**<br>**7** |
| | QUARTZ | $SiO_2$ | Grayish black<br>Brownish black | Vitreous | **7** |
| | GARNET<br>var. Melanite | Silicate of Ca, Fe, Al, and Ti | Velvet-black<br>Brownish black | Vitreous<br>Velvety | **7**<br>**7.5** |
| | **TOURMALINE** | Borosilicate of Al, Fe, and Mg | Coal-black | Vitreous<br>Very glassy | **7**<br>**7.5** |
| | **SPINEL** | $(Mg,Fe)Al_2O_4$ | Grayish black | Vitreous<br>Dull | **8** |
| COLOR WHITE, GRAY, OR COLORLESS. | ULEXITE | $NaCaB_5O_9 \cdot 8H_2O$ | Snow-white | Pearly<br>Silky | **1**<br>**1.5** |
| | **TALC**<br>Soapstone | $H_2Mg_2(SiO_3)_4$ | White<br>Greenish white<br>Gray | Pearly<br>Greasy<br>Dull | **1**<br>**1.5** |
| | **PYROPHYLLITE** | $HAl(SiO_3)_2$ | White<br>Grayish<br>Brownish gray | Pearly<br>Greasy<br>Dull | **1**<br>**2** |
| | CERARGYRITE<br>(Hornsilver) | AgCl | Gray<br>Brownish gray | Resinous<br>Waxy | **1**<br>**1.5** |
| | TRONA | $Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$ | White | Vitreous | **1** |
| | CALCITE<br>var. Chalk | $CaCO_3$ | White | Earthy<br>Dull | **1**<br>**2** |
| | TRIPOLITE<br>Diatomaceous earth | $SiO_2 \cdot nH_2O$ | White | Vitreous<br>Dull | **1**<br>**2** |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Tetrag. | C, not prominent<br>Brittle | 4.2 | Crystals, usually twinned and faces deeply striated | Crystals generally imperfect; knee-shaped twins common |
| Tetrag. | C, not prominent<br>F, uneven, coarse<br>Brittle | 6.8<br>7.1 | Massive; granular; rolled pebbles; twinned crystals | Often with quartz, mica, wolframite, fluorite; heavy black masses |
| Hex. | C, none<br>F, conchoidal<br>Brittle | 2.6 | Crystals; hexagonal prisms and pyramids | Very dark smoky quartz |
| Isom. | C, none<br>F, uneven<br>Brittle | 3.8 | Crystals; rhombic dodecahedrons | Uncommon color |
| Hex. | C, none<br>F, uneven<br>Very brittle | 3<br>3.2 | Crystals; long trigonal-shaped prisms; sometimes divergent columnar | Crystal faces usually striated vertically, and much fractured horizontally; often as coal-black crystals in quartz and feldspar |
| Isom. | C, imperfect<br>F, conchoidal<br>Brittle | 3.5<br>4.1 | Crystals; octahedrons | In granular limestone often with chondrodite |
| | C, not important<br>F, fibrous | 1.6 | Soft fibrous masses divergent columnar | Usually in ball-like masses of fibers, soft as flour, called cotton balls |
| Mono. | C, basal, perfect and prominent in the foliated masses | 2.8 | Foliated; compact massive; fibrous | Soft and greasy feel; fibers usually not radiate like pyrophyllite |
| Mono. | C, basal and prominent<br>Flexible | 2.9 | Fibrous, radiate; foliated; massive | Often in small hemispheres of radiating fibers; soft and greasy like talc |
| Isom. | C, none<br>Sectile | 5.5 | Wax-like crusts; born-like masses | Cuts like wax; often with ores of silver |
| Mono. | C, not prominent<br>F, granular | 2.1<br>2.2 | White friable masses; efflorescences | Tastes alkaline like soda |
| | C, none<br>Brittle | 2.7 | Soft white earthy masses | Resembles white kaolinite, but has no clay odor |
| Amorph. | C, none<br>F, powdery | 2.1<br>2.3 | Soft chalk-like masses | Very light weight; fine gritty powder when rubbed between thumb and finger; may be colored yellow to brown by iron oxides |

COLOR WHITE, GRAY, OR COLORLESS.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| **GYPSUM**<br>var. Selenite<br>Alabaster<br>Satin-spar<br>Common | $CaSO_4 \cdot 2H_2O$ | Colorless<br>White<br>Gray | Pearly<br>Vitreous<br>Silky<br>Dull | **1**<br>**2** |
| **KAOLINITE**<br>(Clay) | $H_4Al_2Si_2O_9$ | White<br>Gray<br>Colorless | Dull<br>Earthy<br>Greasy | **1**<br>**2.5** |
| **BAUXITE** | $Al_2O_3 \cdot 3H_2O$ | White<br>Gray | Earthy<br>Dull | **1**<br>**2.5** |
| SEPIOLITE<br>(Meerschaum) | $H_4Mg_2Si_3O_{10}$ | White | Earthy<br>Dull | **1**<br>**2.5** |
| **TREMOLITE**<br>var. Asbestos<br>Mountain leather<br>Mountain cork | $CaMg_3(SiO_3)_4$ | White<br>Gray | Silky<br>Pearly | **1**<br>**2.5** |
| **SERPENTINE**<br>var. Crysotile or Asbestos | $H_4Mg_3Si_2O_{10}$ | Greenish white | Silky | **1**<br>**2.5** |
| PECTOLITE | $HNaCa_2(SiO_3)_3$ | White | Silky<br>Vitreous | **1**<br>**3** |
| **BORAX** | $Na_2B_4O_7 \cdot H_2O$ | Snow-white<br>Colorless | Earthy<br>Dull<br>Vitreous | **1**<br>**2.5** |
| EPSOMITE | $MgSO_4 \cdot 7H_2O$ | White | Vitreous | **1**<br>**2.5** |
| **HALITE** | NaCl | Colorless<br>White<br>Bluish white | Vitreous | **2.5** |
| SYLVITE | KCl | White<br>Gray<br>Colorless | Vitreous | **2**<br>**2.5** |
| BRUCITE | $Mg(OH)_2$ | White<br>Greenish white | Pearly | **2.5** |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Mono. | C, clinopinacoidal, prominent in selenite<br>Sectile | 2.3 | Colorless crystals and cleavage plates; massive white; fibrous; columnar; granular | Soft and brittle; not so pearly luster as brucite, and softer; compact translucent masses common; soft white masses called gypsite |
| Mono. | C, basal in crystals, none in massive<br>F, earthy<br>Brittle or sectile | 2.6 | Compact massive; rarely in colorless flakes | Rough feeling; soapy var. has greasy feel; strong odor of clay when breathed on |
| | C, none<br>F, earthy<br>Brittle | 2.5 | Compact massive; pisolitic | Distinguished from clay only by pisolitic structure |
| Mono. | C, none<br>F, earthy | 2 | Massive; mammillary; reniform; very compact | Very smooth feel; has not the clay odor of kaolinite |
| Mono. | C, fibrous<br>F, fibrous<br>Brittle | <1<br>3 | Fibrous; asbestiform; sheets, cork-like masses | Occurs with tremolite, feldspar quartz; not green like chrysotile when compact; fibers brittle |
| Mono. | C, fibrous<br>Brittle | 2.6 | Fibrous; asbestiform | Narrow fibrous veins in serpentine; fibers are green in compact mass; fibers like silky threads |
| Mono. | C, not prominent<br>F, fibrous | 2.7<br>2.8 | Divergent fibrous, radiating from sharp points | Flexible fibers very soft and gritless |
| Mono. | C, orthopinacoidal, not prominent<br>Brittle | 1.7 | Crystals; powder | Taste alkaline; white crystals often have fresh, unaltered glassy centers |
| Orth. | C, brachypinacoidal, prominent<br>Brittle | 1.7 | Long acicular crystals; capillary tufts; efflorescences | Taste bitter and salt; often in sulphide mines as efflorescences on walls |
| Isom. | C, cubic, perfect and prominent<br>Brittle | 2.1<br>2.6 | Cubes; massive, granular | Salt taste; sometimes with anhydrite |
| Isom. | C, not prominent<br>F, conchoidal<br>Brittle | 1.9<br>2.0 | Granular; compact | Tastes salt and slightly bitter; resembles halite |
| Hex. | C, basal, perfect and prominent<br>Flexible | 2.5 | Foliated; massive | Resembles gypsum but has more pearly luster; often with serpentine |

COLOR WHITE, GRAY, OR COLORLESS.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| **ANDALUSITE**<br>var. Chiastolite | $Al_2SiO_5$ | Dark gray<br>Blackish gray | Vitreous | **2**<br>**4** |
| **MUSCOVITE**<br>(Mica) | $H_2KAl_3(SiO_4)_3$ | Colorless<br>Gray | Pearly<br>Vitreous | **2**<br>**2.5** |
| **LEPIDOLITE**<br>(Mica) | $(LiK)_2Al_2(F,OH)_2Si_3O_9$ | Pale pinkish white<br>Lavender<br>Gray | Pearly | **2.5**<br>**4** |
| THENARDITE | $Na_2SO_4$ | White<br>Gray | Vitreous | **2**<br>**3** |
| **CRYOLITE** | $Na_3AlF_6$ | Pure white | Icy<br>Vitreous | **2.5** |
| **CALCITE**<br>var. Iceland spar<br>Stalactites<br>Marble<br>Common | $CaCO_3$ | White<br>Gray<br>Colorless | Vitreous<br>Glassy | **3** |
| **ANGLESITE** | $PbSO_4$ | Gray<br>White<br>Colorless | Adamantine<br>Greasy<br>Dull | **3** |
| **CERUSSITE** | $PbCO_3$ | Cream-white<br>Gray | Adamantine | **3**<br>**3.5** |
| **BARITE** | $BaSO_4$ | White<br>Colorless<br>Gray<br>Yellowish white | Vitreous<br>Pearly | **2.5**<br>**3.5** |
| **ANHYDRITE** | $CaSO_4$ | White<br>Bluish white<br>Reddish white<br>Gray | Vitreous<br>Pearly | **3**<br>**3.5** |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Orth. | C, not prominent<br>Brittle | 3.2 | Rounded prisms; square prisms | Occurs in schists often as knotty projections; end sections show black squares or crosses of carbonaceous material |
| Mon. | C, basal, perfect and very prominent<br>Tough | 2.7<br>3 | Micaceous; large sheets; foliated; flakes; scales | Highly flexible and elastic; colorless in thin sheets; cleavable in the thinnest sheets |
| Mono. | C, basal, perfect and prominent<br>Tough | 2.9 | Fine or coarse scaly masses; platy; micaceous; foliated | Compact scaly masses containing pink tourmaline |
| Orth. | C, basal but not prominent<br>Brittle | 2.7 | Crystals often large in cruciform twins<br>Crusts | Slight soda taste |
| Mono. | C, basal and pinacoidal; basal is prominent | 3 | Massive | Snow-ice appearance; often with siderite; cleavage in three directions almost at right angles; translucent |
| Hex. | C, rhombohedral, very perfect and prominent<br>Brittle | 2.7 | Crystals; rhombohedrons; scalenohedrons; granular; stalactitic; banded, etc. | Commonly associated with the metallic minerals; colorless variety is Iceland spar; calcite is apt to be stained any color |
| Orth. | C, not prominent<br>F, conchoidal<br>Brittle | 6.1<br>6.3 | Massive, often banded; crystals | Occurs with galena as an alteration product; crystals are colorless; gray masses often have core of galena and are heavy |
| Orth. | C, not prominent<br>Very brittle | 6.5 | Prismatic crystals; massive | Occurs similar to anglesite; gray masses somewhat porous or reticulated and are heavy |
| Orth. | C, basal and prismatic, prominent | 4.3<br>4.6 | Crystals; crested masses; granular; lamellar; concretions massive | Often with galena; heavy white mineral, called heavy spar; told from marble or anhydrite by weight |
| Orth. | C, pinacoidal, not prominent<br>Brittle | 3 | Massive; granular; scaly | Cleavage in three directions at right angles, making cube forms, occurs with gypsum, limestone |

COLOR WHITE, GRAY, OR COLORLESS.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| **CELESTITE** | $SrSO_4$ | Colorless with bluish tinge<br>White | Vitreous<br>Glassy | **3**<br>**3.5** |
| **WITHERITE** | $BaCO_3$ | White | Vitreous | **3**<br>**3.5** |
| **STRONTIANITE** | $SrCO_3$ | White<br>Yellowish white | Vitreous<br>Glassy | **3**<br>**3.5** |
| **ARAGONITE** | $CaCO_3$ | White<br>Gray<br>Colorless | Vitreous<br>Glassy | **3.5**<br>**4** |
| **DOLOMITE** | $(CaMg)CO_3$ | White<br>Gray | Vitreous | **3.5**<br>**4** |
| **SIDERITE** | $FeCO_3$ | Brownish gray | Vitreous<br>Pearly | **3.5**<br>**4** |
| HEULANDITE | $H_4CaAl_2(SiO_3)_6 \cdot 3H_2O$ | White<br>Light gray | Vitreous | **3**<br>**4** |
| STILBITE | $H_4(Na_2,Ca)Al_2(SiO_3)_6 \cdot 4H_2O$ | White<br>Gray | Vitreous | **3**<br>**4** |
| Alunite | $K_2(Al \cdot 2OH)_6(SiO_4)_4$ | White<br>Gray | Vitreous | **3.5**<br>**4** |
| **FLUORITE** | $CaF_2$ | Greenish white<br>White<br>Colorless | Vitreous<br>Glassy | **4** |
| **COLEMANITE** | $Ca_2B_6O_{11} \cdot 5H_2O$ | Colorless<br>White<br>Yellowish white | Vitreous<br>Very glassy | **4**<br>**4.5** |
| SCHEELITE | $CaWO_4$ | White<br>Gray<br>Yellowish | Adamantine<br>Greasy | **4.5**<br>**5** |
| **WOLLASTONITE** | $CaSiO_3$ | White<br>Gray | Vitreous<br>Pearly | **4.5**<br>**5** |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Orth. | C, basal and prismatic; basal very prominent | 3.9 | Cleavage masses; crystals | Often as colorless crystals with native sulphur |
| Orth. | C, not prominent Brittle | 4.3 | Columnar; hexagonal-shaped crystals with striated faces | Sometimes with galena; heavy snow-white masses common |
| Orth. | C, prismatic, sometimes prominent Brittle | 3.7 | Columnar masses | Divergent columnar masses resembling aragonite or calcite, but much heavier |
| Orth. | C, prismatic but not usually prominent Brittle | 2.9 | Stalactitic; banded; columnar; hexagonal-shaped crystals | Distinguished from calcite by lack of cleavage and by hardness |
| Hex. | C, rhombohedral, sometimes prominent Brittle | 2.9 | Rhombohedrons, with curved faces; massive; granular | Massive variety indistinguishable from calcite except somewhat harder; crystals have curved faces |
| Hex. | C, rhombohedral, very prominent Brittle | 3.8 | Rhombohedrons with curved faces; saddle-shaped masses; compact; massive | Darker and heavier than dolomite; often as rhombohedrons in cryolite; surface often oxidized brown |
| Mono. | C, clinopinacoidal and prominent Brittle | 2.1<br>2.2 | Tabular crystals; foliated plates; globular | In cavities of lava rock often with chabazite, stilbite, apophyllite |
| Mono. | C, clinopinacoidal; not prominent Brittle | 2.0<br>2.2 | Divergent and sheaf-like; platy; globular | In cavities of lava rock. often with chabazite, apophyllite, heulandite |
| Hex. | C, basal; not prominent | 2.6<br>2.8 | Compact massive; granular; earthy | Resembles clay and often with quartz and clay |
| Isom. | C, octahedral, very prominent Brittle | 3<br>3.2 | Cubes; octahedrons; massive; granular | Often with magnetite, pyrite, calcite; sometimes very compact granular |
| Mono. | C, clinopinacoidal, very prominent Brittle | 2.4 | Crystals; massive; divergent columnar | Cleaves into thin brittle plates |
| Tetrag. | C, not prominent Brittle | 5.9<br>6.1 | Crystals; pyramids; massive | Often with cassiterite, wolframite, purple fluorite; very heavy |
| Mono. | C, orthopinacoidal, not prominent Brittle | 2.9 | Fibrous; columnar | Parallel, or reticulated, fibrous masses; often in marble; resembles tremolite but generally longer and whiter |

COLOR WHITE, GRAY, OR COLORLESS.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| **CHABAZITE** | $Ca_3Al_6(SiO_4)_3(Si_3O_8)_3 \cdot 18H_2O$ | White<br>Colorless<br>Gray | Vitreous | **4**<br>**5** |
| APOPHYLLITE | $H_7KCa_4(SiO_3)_8 \cdot 4\frac{1}{2}H_2O$ | White<br>Colorless<br>Yellowish | Vitreous<br>Glassy<br>Pearly on base | **4.5**<br>**5** |
| **CALAMINE** | $H_2Zn_2SiO_5$ | Colorless<br>White<br>Gray | Vitreous | **4.5**<br>**5** |
| **MAGNESITE** | $MgCO_3$ | Snow-white<br>Gray | Vitreous<br>Dull | **3.5**<br>**4.5** |
| **SMITHSONITE** | $ZnCO_3$ | Bluish gray<br>Yellowish gray | Vitreous | **5** |
| APATITE | $(CaF)Ca_3(PO_4)_3$<br>$(CaCl)Ca_3(PO_4)_3$ | Colorless<br>Gray | Vitreous<br>Greasy | **5** |
| **PECTOLITE** | $HNaCa_2(SiO_3)_3$ | White | Silky<br>Vitreous | **5** |
| **NATROLITE** | $NaAl(AlO)(SiO_3)_3 \cdot 2H_2O$ | White<br>Colorless | Vitreous<br>Silky | **5**<br>**5.5** |
| DATOLITE | $Ca(BOH)SiO_4$ | Colorless<br>White | Vitreous<br>Glassy | **5**<br>**5.5** |
| **ANALCITE** | $NaAl(SiO_3)_2 \cdot H_2O$ | Colorless<br>White | Vitreous<br>Glassy | **5**<br>**5.5** |
| **OPAL** | $SiO_2 \cdot nH_2O$ | Gray<br>White | Waxy<br>Vitreous | **5.5**<br>**6.5** |
| **SCAPOLITE**<br>WERNERITE | Silicate of Ca, Al, Na, and Cl | Gray<br>Greenish gray<br>White | Vitreous<br>Silky | **5.5**<br>**6** |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Hex. | C, not prominent<br>Brittle | 2.1 | Crystals, almost cubic in shape | Usually in cavities of lava rock with stilbite, heulandite, natrolite |
| Tetrag. | C, basal, perfect and prominent<br>Brittle | 2.4 | Crystals; short prisms with base; also pointed pyramids | Basal cleavage has very pearly luster, prismatic faces glassy and vertically striated |
| Orth. | C, prismatic and prominent<br>Brittle | 3.5 | Drusy coatings and crusts; small crystals | Often on yellowish brown earthy masses, in small drusy crystallizations and radiating fibrous bands |
| Hex. | C, rhombohedral in crystals<br>F, conchoidal and prominent | 3.1 | Crystals rare; massive, impalpable | Very compact impalpable tough white masses with soiled surfaces; are apparently very hard, but surfaces often soft |
| Hex. | C, rhombohedral, but not usually prominent<br>Brittle | 4.3<br>4.5 | Botryoidal crusts; drusy crusts; bone-shaped masses | Often with sphalerite or calamine |
| Hex. | C, basal, not prominent<br>Brittle | 3.2 | Crystals; massive | Common white phosphate rock; crystals are green or brown usually |
| Mono. | C, not prominent<br>Brittle to tough | 2.7 | Fibrous; divergent, radiate, reticulated | Long white fibers divergent to sharp points; also compact interlocking fibrous |
| Orth. | C, prismatic, prominent in coarse varieties<br>Brittle | 2.2 | Acicular; coarse; columnar; fibrous | Often with stilbite, apophyllite, analcite, chabazite, in cavities of lava rock; usually in more acicular prisms than pectolite and not divergent |
| Mono. | C, none<br>F, uneven<br>Brittle | 3 | Crystals; massive; granular to compact | Small glassy crystals with slight greenish tint on lava rock; massive white |
| Isom. | C, not prominent<br>Brittle | 2.2 | Crystals; icosatetrahedrons or cubes | Often in cavities of lava with apophyllite, natrolite, chabazite, prehnite, datolite; large white crystals |
| Amorph. | C, none<br>F, conchoidal and very prominent | 1.9<br>2.3 | Massive; colloidal; blebby; globular | Wood opal; common opal |
| Tetrag. | C, not prominent<br>Brittle | 2.5<br>2.8 | Square prisms with low pyramidal ends; massive | Crystals usually have rough, uneven faces; often in crystalline limestone |

COLOR WHITE, GRAY, OR COLORLESS.

| | Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|---|
| | **LEUCITE** | $KAl(SiO_3)_2$ | Gray<br>White | Vitreous | **5.5** |
| | ENSTATITE | $MgSiO_3$ | Greenish gray<br>Brownish gray | Pearly<br>Vitreous | **5.5** |
| | **PYROXENE**<br>DIOPSIDE | $CaMg(SiO_3)_2$ | Colorless<br>Yellowish white<br>Greenish white | Glassy<br>Vitreous | **6**<br>**6.5** |
| | **TREMOLITE** | $CaMg_3(SiO_3)_4$ | White<br>Gray | Silky<br>Pearly<br>Vitreous | **5**<br>**6** |
| | **NEPHELITE**<br>ELÆOLITE | $(Na,K)AlSiO_4$ | Greenish gray<br>Brownish gray | Greasy<br>Vitreous | **5.5**<br>**6** |
| | AMBLYGONITE | $Li(Al,F)PO_4$ | White | Vitreous | **6** |
| FELDSPARS | **ORTHOCLASE**<br>SANIDINE | $KAlSi_3O_8$ | White<br>Gray<br>Colorless | Vitreous<br>Pearly | **6**<br>**6.5** |
| FELDSPARS | **MICROCLINE** | $KAlSi_3O_8$ | White<br>Gray<br>Yellowish | Vitreous<br>Pearly | **6**<br>**6.5** |
| FELDSPARS | **ALBITE** | $NaAlSi_3O_8$ | White<br>Colorless<br>Gray | Glassy<br>Vitreous | **6**<br>**6.5** |
| FELDSPARS | OLIGOCLASE | $NaAlSi_3O_8 + CaAl_2Si_2O_8$ | Colorless<br>White | Vitreous<br>Glassy | **6**<br>**6.5** |
| FELDSPARS | **LABRADORITE** | $CaAl_2Si_2O_8 + NaAlSi_3O_8$ | Dark gray<br>Grayish white | Vitreous<br>Pearly | **5**<br>**6** |
| FELDSPARS | ANORTHITE | $CaAl_2Si_2O_8$ | White<br>Gray | Vitreous | **6**<br>**6.5** |

| System. | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Tetrag. | C, imperfect<br>F, conchoidal<br>Brittle | 2.5 | Crystals; trapezohedrons | Always in crystals; occurs in volcanic rocks with nephelite, sodalite as small round crystals |
| Orth. | C, prismatic and pinacoidal, prominent<br>Brittle | 3.1<br>3.3 | Columnar, divergent masses; lamellar | Often soft owing to alteration to serpentine; cleavage faces quite pearly or silky in luster |
| Mono. | C, prismatic, not prominent<br>Brittle | 3.3 | Crystals, almost square or rounded | Often with blue calcite, brown tourmaline |
| Mono. | C, prismatic, prominent<br>Cleavage angle 124° | 2.9<br>3.1 | Columnar; fibrous; prismatic crystals | Often as crystals in dolomitic limestone or marble; also as compact fibrous masses |
| Hex. | C, not prominent<br>Brittle | 2.6 | Massive; sometimes hexagonal prisms | Often with sodalite, albite, leucite; greasy luster characteristic |
| Tric. | C, basal, perfect and prominent<br>Brittle | 3 | Compact massive | Often with lepidolite, tourmaline and white feldspar |
| Mono. | C, basal and clinopinacoidal, prominent<br>Brittle | 2.4<br>2.6 | Crystals; massive; cleavage pieces | Two cleavages at right angles; common in granitic rocks with mica, hornblende, and quartz |
| Tric. | C, basal and brachypinacoidal, prominent | 2.5 | Crystals; massive | Usually has fine cross-veined structure on the basal plane |
| Tric. | C, basal and brachypinacoidal, not so prominent | 2.6 | Small crystals; twinned crystals; platy masses | Fine parallel striations or reentrant angles on the base due to twinning |
| Tric | C, basal and brachypinacoidal, not so prominent | 2.6 | Crystals; massive | Fine parallel striations on the basal cleavage due to twinning |
| Tric. | C, basal and brachypinacoidal, prominent | 2.7 | Massive; cleavage pieces | Fine striations on basal cleavage due to twinning; usually shows a beautiful play of colors; blue, green, gold, etc. |
| Tric. | C, basal, prominent<br>F, uneven<br>Brittle | 2.7 | Crystals; prismatic | Occurs in volcanic lavas; not so common as the other feldspars |

COLOR WHITE, GRAY OR COLORLESS.

| Name. | Composition. | Color. | Luster. | H. |
|---|---|---|---|---|
| ZOISITE | $Ca_2Al_2(AlOH)(SiO_4)_3$ | Grayish white<br>Greenish gray<br>Lavender gray | Vitreous<br>Pearly | **6**<br>**6.5** |
| SPODUMENE | $LiAl(SiO_3)_2$ | Gray<br>White<br>Ash gray | Vitreous<br>Pearly | **6.5**<br>**7** |
| DIASPORE | $AlO(OH)$ | Lavender-gray<br>Grayish white<br>Cream white | Pearly<br>Vitreous<br>Adamantine | **6.5**<br>**7** |
| **QUARTZ**<br>var. Rock crystal<br>Milky<br>Smoky<br>Common | $SiO_2$ | Colorless<br>White<br>Smoky gray | Vitreous<br>Greasy | **7** |
| **CHALCEDONY**<br>var. Agate<br>Chert<br>Flint<br>Hornstone<br>Siliceous sinter | $SiO_2$ | Gray<br>White | Waxy<br>Vitreous | **7** |
| **ANDALUSITE**<br>(CHIASTOLITE) | $Al_2SiO_5$ | Gray<br>Reddish gray | Vitreous | **7.5** |
| LAWSONITE | $H_4CaAl_2Si_2O_{10}$ | Bluish white<br>Gray | Vitreous | **7.5**<br>**8** |
| **ZIRCON** | $ZrSiO_4$ | Brownish gray<br>Lavender-gray<br>Colorless | Vitreous<br>Pearly | **7.5**<br>**8** |
| **TOPAZ** | $Al_2(F,OH)_2SiO_4$ | White<br>Colorless | Vitreous<br>Glassy | **8** |
| **CORUNDUM** | $Al_2O_3$ | Gray<br>Bluish gray<br>Greenish gray | Vitreous | **9** |
| DIAMOND | C | Colorless<br>GRAY<br>Yellowish | Adamantine | **10** |

| System | Cleavage or Fracture. | G. | Common Structure. | Observations. |
|---|---|---|---|---|
| Orth. | C, brachypinacoidal prominent<br>Brittle | 3.3 | Columnar; fibrous; prismatic | Columns deeply striated vertically, and broken transversely |
| Mono. | C, prismatic often prominent<br>Brittle | 3.2 | Large crystals and broad cleavage plates; lamellar | Often parts in broad lamellar masses |
| Orth. | C, brachypinacoidal; prominent<br>Brittle | 3.3<br>3.5 | Bladed; foliated | Often as veins in chlorite with margarite, corundum; very pearly to adamantine luster |
| Hex. | C, none<br>F, conchoidal and prominent<br>Brittle | 2.6 | Hexagonal prisms and pyramids; massive; granular; sand; pebbles | Commonest mineral; occurs in most crystalline rocks as a constituent; conchoidal fracture is characteristic |
| Hex. | C, none<br>F, conchoidal and prominent<br>Brittle to tough | 2.6 | Geodal; botryoidal; mammillary; banded; concretionary; massive | Not glassy like quartz; cryptocrystalline in structure; banded varieties classed as agates; geodes often have quartz centers |
| Orth. | C, not prominent<br>F, uneven<br>Brittle | 3.2 | Almost square prisms with broken ends | End sections of chiastolite show black crosses or squares due to carbon inclusions |
| Orth. | C, brachypinacoidal; prominent<br>Brittle | 3.1 | Crystals; lenticular plates | Often with margarite, actinolite, chlorite; resembles corundum |
| Tetrag. | C, none<br>Brittle | 4.7 | Crystals; prisms and pyramids | Occurs in granites and syenites; loose crystals in gold sands; prominent in concentrates |
| Orth. | C, basal, perfect and prominent<br>Brittle | 3.4<br>3.6 | Crystals; white massive | Massive white distinguished from white quartz by presence of cleavage faces |
| Hex. | C, rhombohedral, prominent<br>Tough | 3.9<br>4.1 | Massive; barrel-shaped crystals | Often with chlorite, margarite, magnetite; massive; has usually fine parallel parting striations |
| Isom. | C, octahedral, not prominent<br>Brittle | 3.5 | Small rounded octahedral-shaped crystals | Occurs in dark bluish-green igneous rock |

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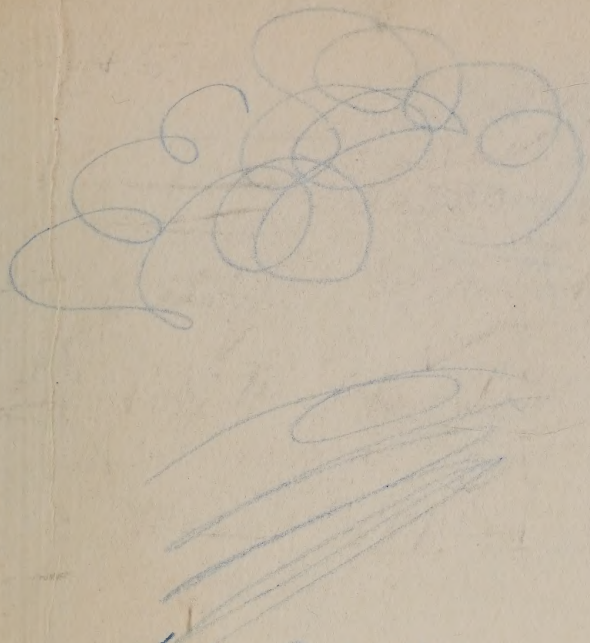

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